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ABSTRACT

A project was devised to develop and test a revision model for systematically designed educational materials based on the literature and on previous procedures. The model divides the revision process into content changes and procedural changes, and decisions are based on data collected from measures of student performance and attitudes and on judgments of a content expert and educational technologist. Students in a required course in health education were subjects for the implementation phase of the project; they were randomly assigned to either computer managed instruction (CMI) or to conventional instruction. The implementation of the revision model was based on the results from the first quarter of operation, where only 17 percent of the CMI students reached criterion of 80 percent on the final, criterion-referenced examination. After revision of the course according to the model, 71 percent of the students in the CMI group reached criterion. While the model was clearly successful, several revisions could be made concerning criterion measures, data collection procedures, evaluation instruments, and student pacing. (Author/SH)

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TECH REPORT

AN EMPIRICAL STUDY OF A METHODOLOGY FOR THE REVISION OF SYSTEMATICALLY DESIGNED EDUCATIONAL MATERIALS

Gail Treat Rayner

Tech Report No. 24
March 1, 1972

Project NR 154-280
Sponsored by
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This study involved the development, implementation, and empirical testing of a revision model for systematically designed educational materials. The investigation provided needed empirical evidence that given a revision subsystem, instructional materials and course operational procedures can be developed which insure that a high proportion of students reach a given level of mastery.

The development of the revision model was based on the limited literature on formative evaluation and upon several documented, data-based revision procedures. The model divides the revision process into two parts, content changes and procedural changes. The former, content changes, focuses on modules, objectives, diagnostic items, instructional materials, and the remedial prescriptions. Revision decisions are based upon data

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collected from measures of student performance, attitudes, and opinions, and upon the judgments of a content expert and an educational technologist. The types of revision are (1) inclusion, exclusion, or changes in scope, and (2) increased congruence of objectives, items, instructional materials and prescriptions. The criteria for determining the need for changes are item error rates, unit and total scores, and student comments.

Procedural revision refers to changes in the instructional process. The focus is on pretesting, orientation, in-course operations, posttesting, and grading. Revision decisions are based on the same data as that used for content changes, as well as solicited comments from students. The kinds of procedural revisions are those changes related to the type and manner of data collection, information flow to the students, sequencing, pacing, student and teacher roles, and the grading system. The criteria for judging the need for changes, in addition to performance data, are students' and experts' judgments.

The revision model was implemented with a required course in health education for elementary education majors at Florida State University. The subjects were the students enrolled in the course in each of two successive quarters. Sections of the course were randomly assigned to two treatments: computer managed instruction (CMI) and conventional instruction (CI). The instruction in the CMI sections was individualized while the CI sections were professor managed and group paced. The instructional materials for the course were developed using a systems approach model. The instruction was modularized; each module included: objectives, sample test items, selected instructional materials, diagnostic tests, remedial prescriptions, and posttests.

The implementation of the revision model was based upon the results from the first quarter of operation. During the first implementation of the course only 17 percent of the students in the CMI group reached criterion of 80 percent or more on the final, criterion-referenced examination.

The course was revised between quarters according to the revision model. The results of the use of the model were evaluated in terms of overall student performance as well as sub-unit performance by items, objectives, and modules. Time to course completion, attitudes, and special questionnaires were also analyzed. With the revised course, 71 percent of the students in the CMI group reached criterion. Attitudes were unchanged.

Identifying those components of the revision model which were most effective was made difficult by the model itself since its purpose is to identify deficiencies at numerous sources in each instructional unit. Since each objective had a unique set of deficiencies, only the identification of the appropriate problems and the selection of appropriate solutions would result in improved student performance.

On the basis of the empirical test of the model, several revisions are suggested. For instance, it appears that criteria for all unit revisions should be equal to or greater than the criterion for the total course. Additional suggestions are related to data collection procedures, evaluation instruments, and student pacing.

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Florida State University

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CHAPTER I

INTRODUCTION

Background

Currently, in the literature, there is a proliferation of generalized and specialized systems models for the design of instructional materials. Increasingly, the criterion for judging instructional materials is student performance. The concept of student performance criteria is espoused especially in mastery models (Bloom, 1968; Mayo, 1970). The desired instructional outcome is exemplified by Bloom:

> Most students (perhaps over 90%) can master what we have to teach them, and it is the task of instruction to find the means which will enable our students to master the subject under consideration. Our basic task is to determine what we mean by mastery of the subject and to search for the methods and materials which will enable the largest proportion of our students to attain such mastery [p. 1].

It is evident that this description begs the question of both methodology and materials for mastery learning. A demonstration of mastery learning is given in the Short, Geear, Houghey, and Tien (1968) study at AT&T, involving an automated self-instructional course. A second study, by Markle (1967), demonstrated mastery learning in a small group multimedia instructional situation. In these two successful courses, both a form of systems approach and empirical revision were used for the development of materials and procedures.

A number of investigators have suggested that the concept of evaluation be broadened to include the gathering of data for the revision of instructional materials. However, no models exist for developing

materials which result in student mastery. Wittrock (1969) called for evaluation of the learning environment, the learner, learning outcomes and the instruction. Further, Scriven (1967) saw evaluation as having multiple roles and goals, including costs, secondary effects, pay-off, and intrinsic evaluation, to name a few. Although one of Scriven's major contributions is the concept of formative evaluation, no procedures are given. Dick (1968a) defines formative evaluation:

> Formative evaluation comprises those activities which take place during the actual development of the curriculum materials; these activities are conducted by an evaluation specialist who is sympathetic with, and a part of, the curriculum development team. His task is to gather both quantitative and qualitative information which is fed back to the writers and developers in order to revise and strengthen the program. The emphasis in formative evaluation is on what the students don't learn as opposed to what they do learn. The "negative" information which is gathered can be utilized to restructure and rework those portions of the curriculum which are not achieving their objective [p. 1].

A formative evaluation subsystem is either specified or implied in the systems models, but beyond the statement that evaluation is to be based on student performance, little in the way of procedures or criteria for revision is specified. Although more and more instruction includes objectives, individualized learning materials and criterion referenced tests, mastery is not often achieved.

Other than the two cited examples, and a third study done in Korea (Chung, 1970), there is little empirical evidence that mastery learning by a high percentage of students is a readily attainable goal. Acting upon the premise that one of the weaknesses can be traced to the lack of specificity in the instructional design models, the

objective of this investigation was to develop a revision subsystem, based on the mastery model of Mayo (1970), and the empirical studies of Markle (1967), Short et al. (1968), and Chung (1970).

Statement of the Problem

Preparation of learning materials that insure a high level of mastery by most of the students using them is a difficult goal to attain. A system of revision for materials is a possible way to work toward that. While the systems models call for formative evaluation in order to produce student mastery, no formal revision models are proposed. The empirical studies demonstrate that mastery can be achieved, however, the revision procedures are project specific.

Purpose of the Study

The primary purpose of this study was to design, develop, and empirically test a revision component for a generalized systems model. A revision component is the subsystem often indicated only by feedback arrows in a schematic drawing. It is usually mentioned but rarely explicated in instructional design models.

The criteria for assessing the effectiveness of the proposed revision model were as follows:

1. How effective was the sum of the revisions with respect to a preset goal of 80 percent mastery for 80 percent of the students for the entire course?

2. How effective was the sum of the revisions with respect to a preset goal of 75 percent mastery for 80 percent of the students for each module?

3. How effective was the sum of the revisions with respect to a preset goal of 75 percent mastery for 80 percent of the students for each objective? (The criterion level of 80 percent is acknowledged to be arbitrary. This level was chosen because it is consistent with Bloom, 1968.)

Additional data were collected with regard to the following questions:

1. What was the effect of revisions on student performance, learning time and attitudes?

2. What were the effects of revisions on a modified conventional class?

3. Are there individual differences in selected student learning styles (e.g., preferred strategy), to which individualized courses should be adapted?

4. Based on the results of the implementation of the revision model, what changes should be made in the model?

The present investigation critically examined these questions within the context of an objectives-based, individualized college course. The effects of the revision process on student performance were evaluated in two instructional contexts, a professor-managed, group-paced, class, and a computed-managed, individualized course.

This investigation provides needed empirical evidence that given a revision subsystem within a systematic model of instructional design, instructional materials and course operational procedures can be developed which insure that a high proportion of students reach a given level of mastery.

This study is seen as an initial effort to develop a revision model based upon the limited literature and upon previous data-based revision procedures. It is anticipated that numerous specific research studies in this area will be required in order to develop a valid and reliable model. The present study is a first step toward that end.

Overview of Study

In the second chapter, a selective literature review is presented in the areas of systems and revision models, and computer managed instruction.

The third chapter describes the proposed revision model and the rationale for its development.

The methods and procedures for conducting the investigation of the effectiveness of the model are specified in the fourth chapter. This includes the development of materials and the instruments used for collecting the data.

The results of the investigation are reported in the fifth chapter and a discussion of the results and suggested changes for the model are presented in the sixth chapter. The final chapter is a summary.

CHAPTER II

REVIEW OF THE LITERATURE

The literature related to revision models is divided into two categories: instructional requirements for mastery learning and the revision component of systems models. Descriptions from the systems models are either (a) specific models, or (b) revision sections of reports of the implementation of such models. Since the model was applied to a course which was implemented via computer-managed instruction (CMI), it is also briefly reviewed.

Instructional Requirements for Mastery Learning

The mastery model described by Mayo (1970) was partially based on the work of Bloom (1968) and on that of Carroll (1963). Mayo lists five component strategies for the achievement of mastery by learners:

1. Inform students of course objectives, down even to the unit level, in order that they view learning as a cooperative instead of a competitive situation.
2. Set the standards of mastery in advance and assign grades in terms of performance instead of on the basis of relative ranking.
3. Use short diagnostic progress tests for each unit of instruction.
4. Prescribe additional learning experiences for those students who do not reach criterion.
5. Provide additional learning time for those students who need it.

Some intended effects of employing this strategy are that (a) specification of objectives before the instruction takes place can be used

to affect the expectations of teachers and the goals of students (Bloom, 1968); (b) the module tests help pace student learning and enable the instructor to analyze instruction before it is too late to correct difficulties; and (c) knowledge that extra effort will eventually produce high grades on the summative evaluation instruments (and thorough mastery of the subject) should be a motivating factor (Bloom, 1969). While all of these are reasonable suggestions, it does not tell the author what to do if he has done all these things in the original development and the students still do not achieve mastery.

Systems Models

Specific Models

The course used in this investigation was developed using a systems approach. This investigation centers upon the formative evaluation block and the feedback loops as in Dick's (1968b) model, illustrated in Figure 1.

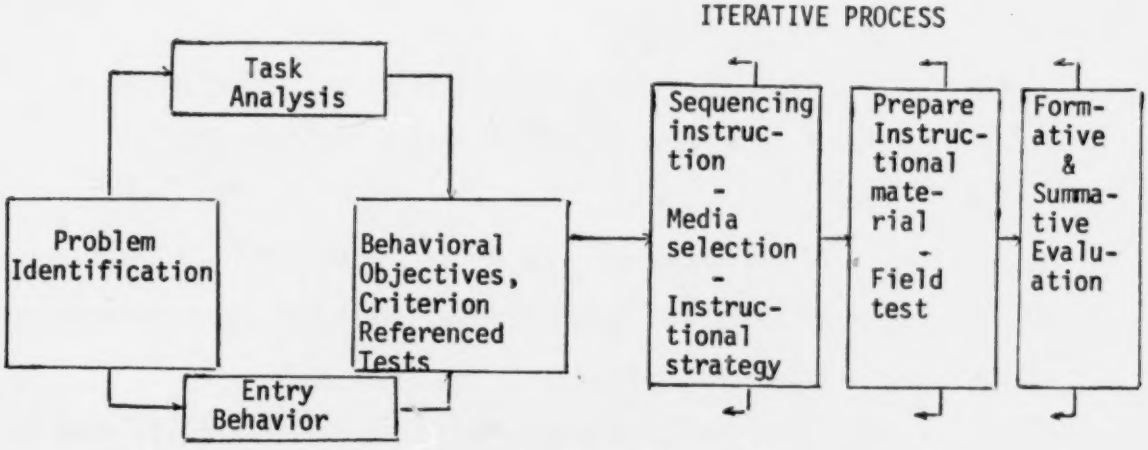


Figure 1.--Schematic representation of Dick's model.

A description of representative examples of systems models that have a formative evaluation component follows:

Briggs' (1970) model requires formative evaluation, the extent of which is dependent upon the budget constraints and the value of effort extended to achieve increasingly smaller increments in effectiveness. No set rules are offered.

Formative evaluaton in Dick's model, as described by Hagerty, 1970, is based on pre- and posttests. This information should be used to improve not just the instruction, but the whole process.

Eraut's model (Lipe, 1970) describes testing of each subsystem (portion of a course) on individuals with iterative revisions of the task analysis and/or production of materials until satisfactory performance is achieved.

Although Glaser does not mention "formative evaluation" in his model, he quotes Lumsdaine on the greater value of assessing instruction and revising it before it is placed on the market. Glaser's model uses evaluation of the students' terminal performance as feedback to the instructional designer to make revisions so that each student reaches criterion.

The PIERIM model (Lipe, 1970) identifies revision responsibilities for the instructor and for the educational technologists, but no criteria are specified for making decisions about revisions.

The audio-tutorial system (Postlethwaite, Novak, and Murray, 1969) suggests using students in (a) the development of materials, (b) the evaluation of topics and items at the weekly planning sessions, and

(c) a "brainstorming" session at the end of the course. Topics that need improvement are discussed and a record is kept of modifications suggested or approved.

The Army Ordinance Guided Missile School has a special purpose model for designing instructional materials for army trainees (Northrup & Shettel, 1964). Although similar to other systems models in most respects, it calls for revision on the basis of the graduates' on-the-job performance, rather than only on final test performance.

In summary the various systems models suggest that the following should be considered in the revision process:

a. budgetary constraints
b. pre- and posttest performance
c. empirically testing the course subsystems
d. use of students in materials development
e. brainstorming sessions with students and staff
f. on-the-job performance after learning.

However, there is no one model that proposes a complete subsystem for revision for mastery.

Revision methodology

Dick (1968a) prepared a seven-point revision methodology to be used by the writers of a programmed college calculus course, which was adaptable to individualized instruction. The process included:

1. Analyzing unit test items to determine concepts most often missed by students.
2. Studying incorrect response to determine what caused the error.

3. Relating missed items to frames in the program.
4. Studying error rates on frames that match missed items in order to revise frames.
5. Studying incorrect responses by segment to determine the nature of the learning difficulty.
6. Studying the comments of students and program reviewers for problem areas.
7. Adding frames if there are none corresponding to a missed item.

Dick reports that the content writers felt that frame error rates and reviewer comments were the most informative data. However, few of the writers used much of the other information extensively, and no validation is available.

In a recent dissertation study, Brennan (1970) developed a discrimination index for criterion referenced test items to use for revision decisions. He has prepared a table of the decisions indicated by many possible combinations of "high" or "low" on several error rates, and positive, negative, or no discrimination indices. However consideration for change is given only to test items or instruction, and the only sources of data which might be used are pre- and posttests. In addition, the author considers that at least one-third of the decisions derived from the theoretical decision table would be of a questionable nature.

Applications of Systems Models

In contrast to the foregoing, revision processes have been described for several projects, but model development was not the focus of the project. Two training courses were developed by American Institute

for Research for American Telephone and Telegraph Company. A Red Cross safety course (Markle, 1967) was not individualized. The other, dealing with critical skills of long lineman (Short, et al., 1968), was both self-instructional and automated.

Markle developed instructional materials that reduced American National Red Cross first aid instruction time from 10 hours to 7 1/2 while moving the final score distribution so much higher that the lowest score on the new version was higher than the highest score on the standard version. The developmental methods were explicitly described. Item revisions were based on response time, error rate, and consistency with objectives. Subjects provided comments to revise both items and objectives. An iterative process of empirical testing on the basis of student performance followed until the preset goal of 7 1/2 hours was reached.

Some of the techniques applied to achieve the goals of higher performance for more students were: (a) questions were revised to eliminate ambiguities and questions representing material already known by the student population were dropped; (b) redundancies were removed; (c) instructional films were made and student difficulties were used as a basis to revise them; (d) a review unit was constructed for the end of the course by selecting critical questions from each lesson; (e) explicit instructor guides were tested and refined; (f) instructional workbooks were revised with an emphasis on time saving without sacrificing instructional quality; and (g) procedural skills films and practice sessions were resequenced.

The second project was to develop a fundamentals training course for the Long Lines Plant Department (Short, et al., 1968). The course was developed in a series of gradual approximations of the final version. To facilitate revisions, lessons were taped and a log book was kept of student questions, problems in learning, and instructor deviations from the planned lesson. In addition, attitude measures, student ratings, time to completion, and notebooks showing what students did learn were used. Feedback from supervisors of graduates, although collected, was not found to be helpful.

A third mastery learning project was that of Chung (1970) conducted in Korean schools. Materials were carefully programmed using a modified combination of Bloom's Learning for Mastery (1968) and Caroll's Model of School Learning (1963). Modifications were those imposed by the constraints of a Korean school. For instance, because 70 students are typically assigned to a class, cooperative small group study was encouraged. In the first trial on a unit in seventh grade mathematics, 74 percent of the experimental group reached the 80 percent criterion while only 40 percent of the control group did. Results were not as spectacular on the first trial in several other content areas, but more of the experimental than control group students attained mastery in each content area. Revision of the courses is not described beyond the addition of a special motivating course. Because only a few classes in the experimental group performed poorly, the teachers of those groups were interviewed. After the investigator noted a distinct lack of teacher enthusiasm for the new materials, indoctrination sessions

were held for those teachers. The end result was higher student performance on the next trial.

Summary

Although none of these projects deliberately set out to develop or validate a revision model they did include the following procedures:

a. Analyzing test items, especially errors
b. Studying student comments
c. Studying program reviewers comments
d. Checking consistency of items with objectives
e. Empirical testing of materials
f. Providing review units
g. Resequencing of content
h. Keeping a log of problems
i. Keeping a record of student time to completion
j. Collecting attitude data
k. Providing motivational help

It should be noted that 4 out of 11 correspond to those already described under systems models.

Computer-Managed Instruction

CMI is viewed as a method for realizing the potential of the computer in individualizing the educational process. Jerman's (1970) formulation of computer-mediated instruction is much like the system used in this investigation. The functions ascribed to CMI by Jerman are (a) introduce a topic; (b) test; (c) prescribe appropriate off-line materials for study; (d) review the off-line material; (e) retest; (f) report to the teacher; and (g) introduce a new topic.

Baker (1971) describes a composite computer based instructional management system (CBIMS) as:

> The curriculum with which one uses a CBIMS is usually built around units of instruction. Typically, these are specified in terms of educational objectives: desired student behavior, levels of competence, concepts to be learned, or a given program of instruction. . . . . The four major functions performed by computers in existing instructional management systems are test scoring, diagnosing, prescribing, and reporting. These are incorporated into the curriculum in the following way:
>
> At the beginning of each unit of instruction, a pretest is taken by each pupil . . . . On the basis of the pretest results, the pupil is assigned to specific learning tasks . . . . At various points within a unit the pupil may take diagnostic or progress tests . . . . When a pupil has completed the assigned tasks, he takes a posttest covering the unit of instruction. This test is criterion-referenced . . . . If a pupil fails to reach criterion performance, two alternatives are available. He can be subjected to remedial procedures, or the failure can be ignored and he can proceed to the next unit of instruction.
>
> After the administration of each test, the teacher receives several printed reports [pp. 52-53].

At Florida State University CMI varies from Baker's composite model in that students' interact on-line with the computer (Hagerty, 1970; Lawler, 1971). Such on-line data collection is atypical of CMI systems (Brudner, 1969).

Two CMI studies at Florida State preceded and influenced the present study. The first (Hagerty, 1970) dealt with the development and implementation of a graduate level course via CMI. This course, Techniques of Programmed Instruction, was implemented in the fall of 1969 with 59 graduate students. An important feature of this approach was the student-terminal interaction which has previously been discussed. The components of the CMI logic included diagnostic testing, remediation,

record keeping and data collection. No direct instruction was presented at the terminal; a printed study guide directed the students to textbooks and other printed materials. This particular study merits special attention in that the basic format used in materials development of this investigation most closely approximates that used by Hagerty.

The other study, which was concurrently conceived and implemented with this study, was that of Lawler (1971). Some of the comparative data used in the present study was obtained during the one conducted by Lawler. The Lawler study compared three treatments within CMI. One group received remedial prescriptions on failed objectives and each student was required to reach 80 percent mastery on each module before selecting another. The second group received prescriptions but were not permitted to retake failed tests. The last group received no prescriptions and were not permitted to retake failed tests. The prescription and forced mastery group did significantly better than the no prescription or the no required mastery group; in addition, the results demonstrated a general superiority of the CMI groups over a conventional group on the criterion measure.

Summary

Several research efforts which are related to the current study have been reviewed in this section. In general, these results indicate that while the systems models call for formative evaluation in order to produce student mastery, no formal revision models are proposed. The empirical studies demonstrate that mastery can be achieved, however, the revision procedures are project specific. CMI would appear to be a reasonable vehicle for investigating a revision model.

CHAPTER III

DESCRIPTION OF THE REVISION MODEL

Almost all systems models have tended to ignore the specifics of the revision process. An attempt has been made in this investigation to build a general revision model and to then apply it to a specific course. The type of course to which the model can be applied must: (a) have been developed using some systems model; (b) include the following subcomponents: specific objectives clustered in some unitized way commonly called modules, instructional materials, corresponding criterion referenced diagnostic tests, remedial prescriptions, and pre- and posttests. These are required in order to obtain information necessary for revision.

This chapter contains a definition and description of each component of the revision model. The inputs, or sources of data for use in the model, are students, content experts and educational technologists. The use of the model results in recommendations for changes in the two major components of a course: content and procedures. Chapter V will describe the implementation of the revision model with a course which met the criteria listed above.

Flow charts of the model are presented in Figures 2, thru 11. The first details the inputs and revision components. Figures 2 thru 6 show the content revisions and Figures 7 thru 10 the procedural revisions. Figure 11 is a summary.

The Sources of Revision Information

The two components, content and procedural revisions, interface at the common data base of student and expert supplied information.

The relationship of the two types of revision and the data sources are shown in Figure 2.

Students

Scott and Yelon (1969) and Bloom, Hastings, and Madaus (1971) espouse the idea of using the student as co-author of instructional materials. However, the majority of studies have used the feedback from students as the main input to the revision process. In the proposed flexible revision model, data on student performance in a field trial are used to improve the instruction in the next trial. The exact changes are dictated by three factors: the structure of the course, the objectives, and how nearly the objectives are reached. Therefore, information from any unit suggests different alternatives. However, a systematic identification of course content and associated instructional procedures facilitates the selection and administration of measuring instruments in a logical way to maximize feedback for the revision process. The measuring instruments include not only content examinations and attitude scales, but also an extensive collection of student comments, both informal and solicited.

Experts

The content expert not only reviews the data collected on students but also makes suggestions based on his professional experience. The educational technologist should use his past experience in the application of systems principles.

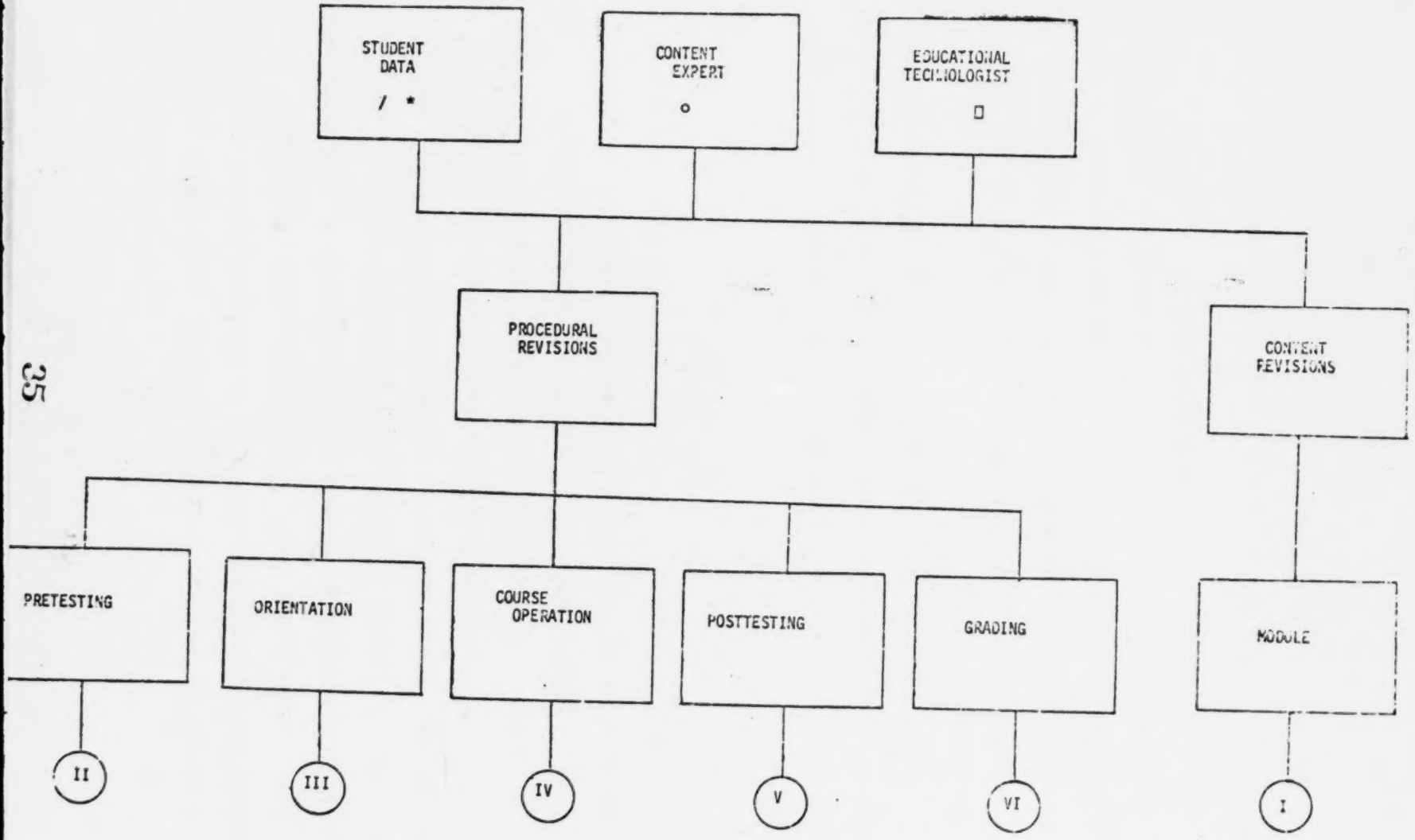


Figure 2.-- Flow chart of revision model depicting relationship between data sources, content revision, and procedural revision.

Key
/ Student attitude or opinion data
* Student cognitive data
o Content expert's judgement
□ Educational technologist's judgement

The revision process can be divided into two aspects (a) content revision, and (b) procedural revision. These are discussed below.

Content Revision

Content revisions can be made on six components of instruction: modules, objectives, diagnostic test items, pre- and posttests, instructional materials, and remedial prescriptions. All of these are interdependent; i.e., a change in any one may necessitate corresponding changes in any or all of the others.

While one could begin the revision process at any component, one of the decisions to be made at the module level is one of its total inclusion or exclusion, and therefore it appears to be the most logical place to begin.

Modules

A module is defined here as one or more objectives clustered by some common denominator such as content area, evaluation context, or any other logical grouping. It is a basic unit of instruction that is self-contained, and includes objectives, instructional materials, diagnostic items, remedial prescriptions and a posttest. Module revisions are based on the answers to the following questions: "Should this module be retained or dropped if it is presently included?" and "Should it be added if not already a part of the course?" The resulting decision is based on the opinion of the content expert and on the reactions of the students to the amount of materials, content coverage, and relevance of the unit. If there is too much or too little material

for the time allowed, the content expert can determine the priorities for additions or deletions. The parts of a module and the revision decisions are described below.

Objectives

An objective is defined as a statement of the behavior a student will exhibit to demonstrate mastery of some unit of instruction. It is the smallest complete unit of a course. A cluster of related objectives defines a module. Objectives are revised on the basis of student performance on items associated with the objectives, student attitudes, and the content expert's opinion.

Bloom et al. (1971) recommend 80 percent to 85 percent levels of accuracy on a criterion-referenced test as an indication of mastery of an objective. If higher levels of mastery are established, such as 95 percent to 100 percent, there are likely to be too few students who achieve this level, thus leaving the majority with little positive reinforcement for mastery. Lower levels of mastery (50 percent to 60 percent) will give too many students the illusion of mastery when in fact they have made many errors.

The investigator thinks that if students do not reach the stated criterion on the objective, the available instructional materials and the test instrument itself should be reviewed along with the statement of the objective. Student comments are an aid in pinpointing difficulties. If students fail to reach criterion on the posttest, then the wording of the objective, the instructional materials, and the remedial

prescriptions are all suspect. All three should be keyed to the test items and vice versa. Figure 3 is a flow chart of the module and objective revisions.

Diagnostic items

Diagnostic items are defined as those items used to test mastery prior to a final examination. If the proporation of students passing a diagnostic item is lower than a preset rate such as 40 percent, its congruence with the objective, the instructional materials, as well as its own construction are possibilities for revision. Additional useful information can be gained from students' comments, or more likely, complaints. The decisions to be made for item revisions are shown in Figure 4.

Pre- and posttests

For a course that is still in the formative stage, which was developed using a systems model, the pre- and posttests should either be identical or alternate forms. Only by using the same or equivalent instruments can one draw conclusions about student gains. The pre- and posttests are also part of the formative evaluation of the instructional materials being developed.

Given a well-written item, very low error rates on the pretest generally indicate that the item covers previously acquired knowledge and should therefore be eliminated. Markle (1967) dropped questions if too many of the intended student population answered them correctly on the pretest. No strict numerical criterion was applied. When such an item is dropped, matching instructional material should also be

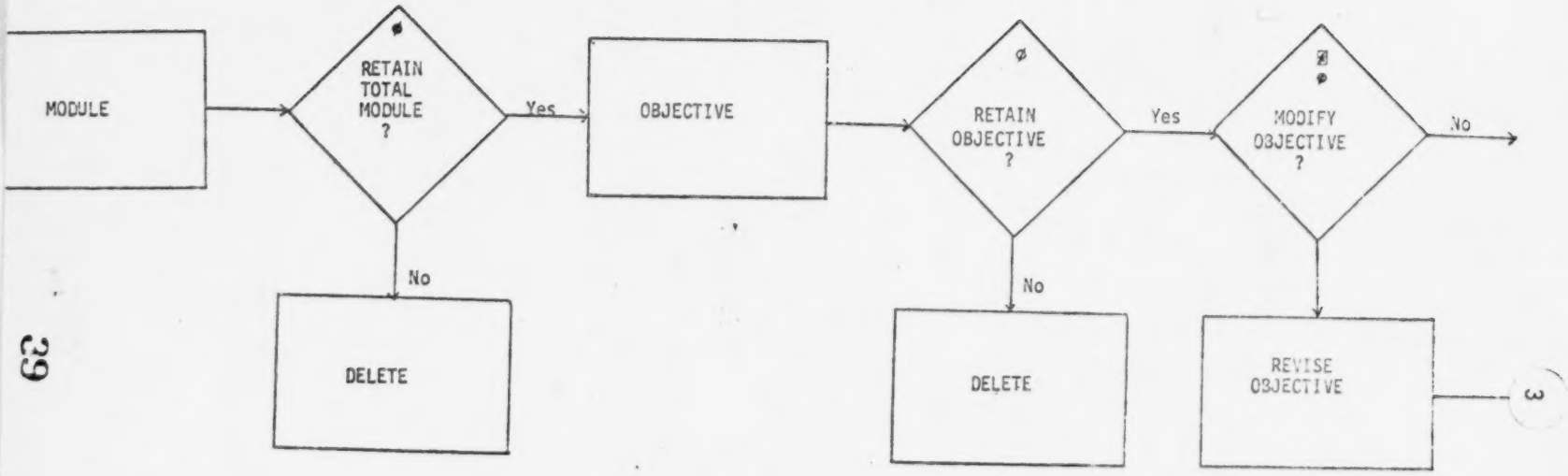
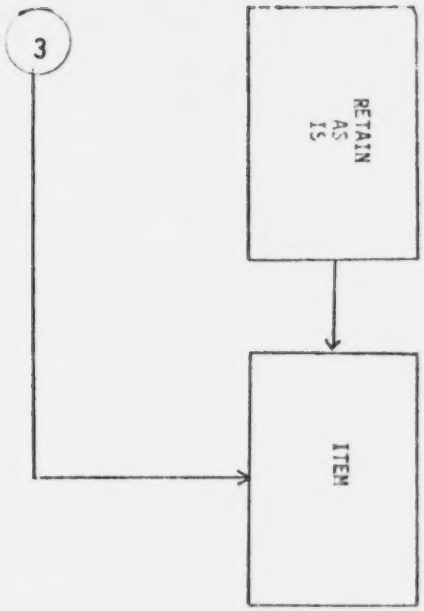


Figure 3.-- Flow Chart of Content revision decision points for modules and objectives.



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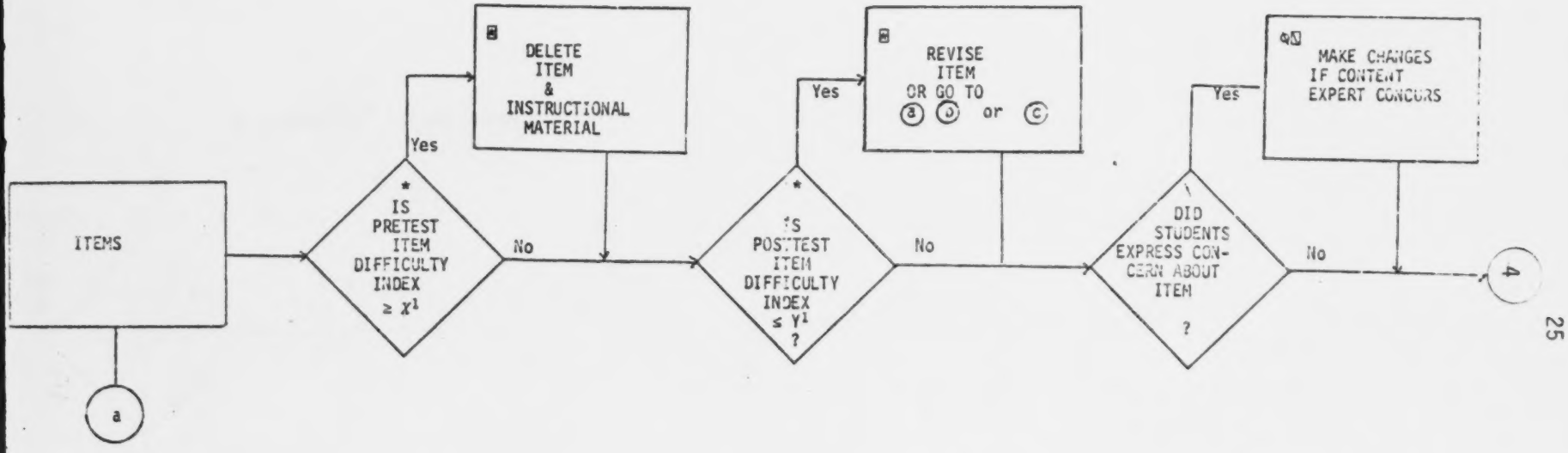
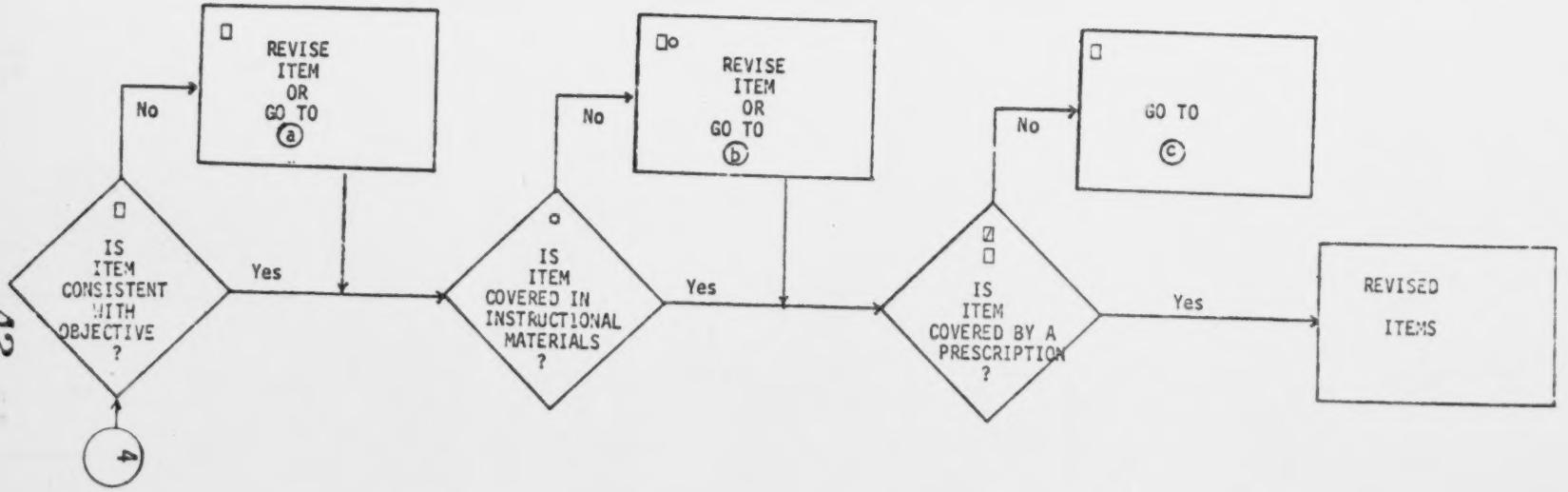


Figure 4.-- Flow Chart of Content item revision.

[1] Set x equal to a percentage which is consistent with the proportion of students with prior knowledge one is willing to have repeat already mastered material.

Set y equal to the difficulty level consistent with the level of mastery criterion.



G Figure 4.-- Continued

eliminated. The pretest item difficulty level that is set is related to how much already mastered material the students should repeat.

If the preset percentage of students does not reach the mastery criterion on the posttest, at least one or more problems exist in either the objectives, instructional materials, or remedial prescriptions.

Instructional materials

The instruction may be in any medium, with either one medium or multiple media options for each objective. If media alternatives are given, the most effective ones should be recommended. Materials which prove to be redundant or irrelevant (based on student comments) should be excluded. Too great a volume of material, given the time constraints, should be reviewed and reduced with no decrease in effectiveness.

Student comments are a good source of such information. Also, further data analysis can be conducted. This is done by matching the entire item pool (sample, diagnostic, and pre- and posttest items) for an objective with the corresponding learning materials. Material that is not needed for continuity or background, or that does not match the objective, can be eliminated. A flow chart of the decision points for revision of instructional materials is given in Figure 5.

Remedial prescriptions

A remedial prescription can be described as a study guide given to a student after he has failed to meet criterion on a module or progress test. Such a study guide can take many forms. It

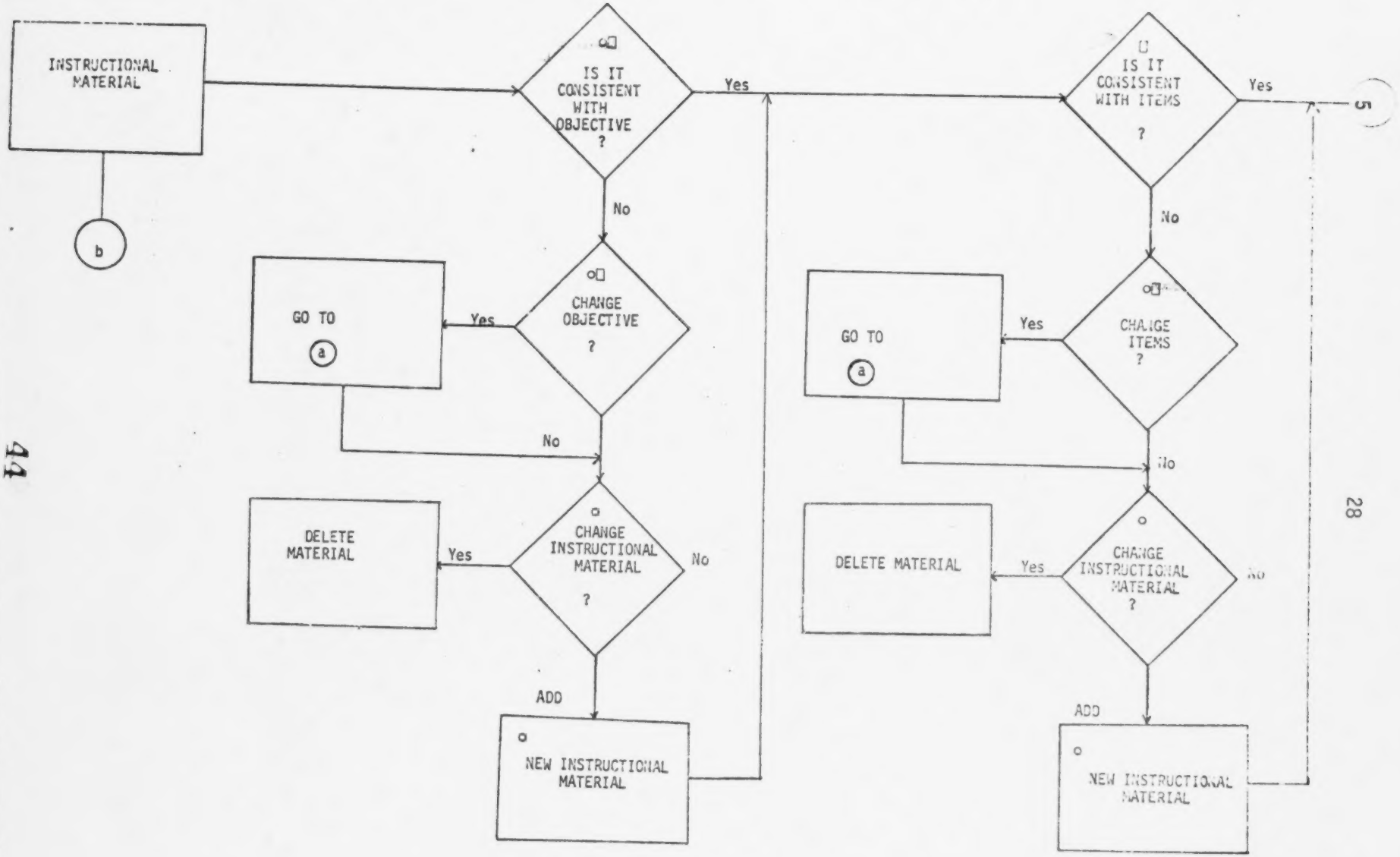


Figure 5.-- Flow chart of instructional materials revision

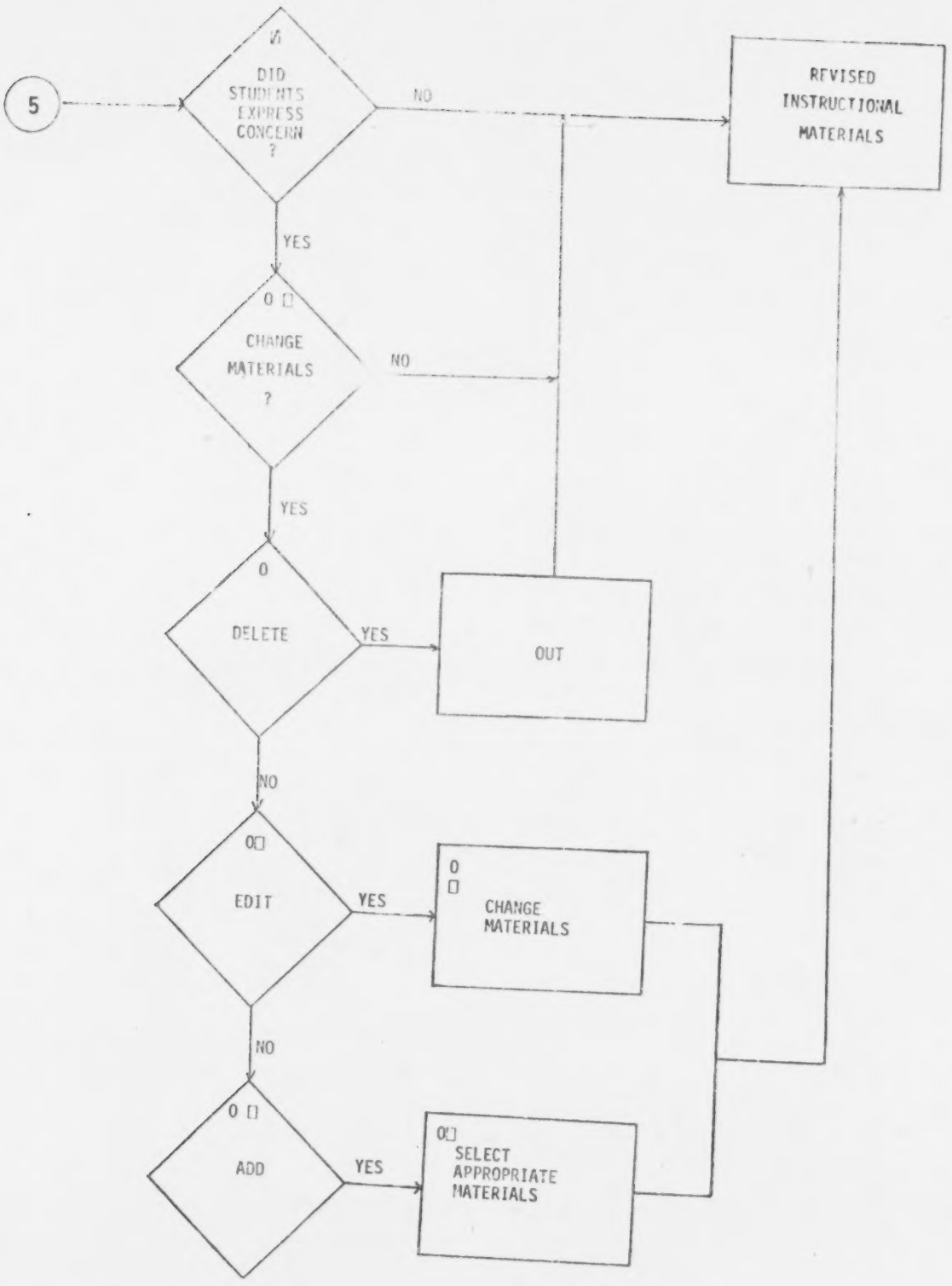


Figure 5.-- Continued.

may (a) simply redirect the learner to what he was to have already done, (b) suggest an alternative instructional option, (c) clarify the objectives, (d) list study questions, or, (e) provide remedial paragraphs. Bloom et al. (1971) suggest keeping a record of student errors, and giving the student not only the error information, but also a detailed prescription of the instructional materials he should study to bring about mastery. The effectiveness of prescriptions is measured by the student gain from the formative to the summative evaluation, i.e., the change in student performance from the module examination to the final examination. Figure 6 is a flow chart presenting the revision of prescriptions.

Procedural Revision Component

Procedural revisions include all operational changes made in the process of providing instruction to students. Information to make procedural revisions is gathered informally from students, their comments or complaints, and by the critical observation of the course operation by the educational technologist. Suggestions from the former and alternatives proposed by the later make up the data base. Alternatives that would appear to improve student performance, save the student time or make the learning experience more pleasant should be tested.

The model proposes that attention is focused on problems by criticisms from students. The alternatives selected to alleviate problems can be based upon the best available information on learning. For example, if students complained about forgetting, an appropriate review system could be added.

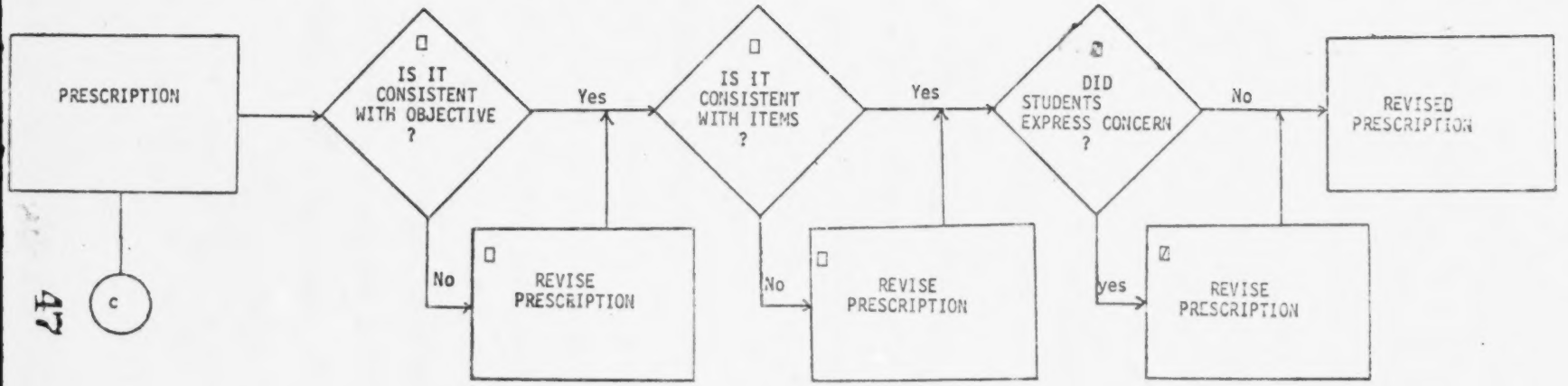


Figure 6.-- Flow chart of content prescription revision.

The criteria for judging procedural revisions are principally formal student responses to the changes collected at the end of the course. The process of administering a course can be divided into five time phases: pretesting, orientation, instructional operation, posttesting and grading.

Pretesting

Before instruction begins, pretesting information must be collected on basal student characteristics that will be necessary for measuring student change during or at the end of the course. This information should include attitudes toward (a) the subject matter, (b) media of presentation, and (c) mode of presentation. In the developmental stages of a course, students should be pretested on the terminal performance in order to distinguish prior knowledge from knowledge acquired in the course. Appropriate instruments must be selected, modified, or developed for this purpose. An entry behavior test would be necessary at this point for instruction that is dependent on specific prerequisite skills. The principal revision at this point would be in the use of the pretest. The criterion for judging if a change was helpful is student comment. A flow chart of pretest procedures revisions are presented in Figure 7.

Orientation of Students

The orientation of students is critical for two reasons. First, since a highly structured or systematic course is unfamiliar to many students, the innovative procedures may need explanation. Second, if the curriculum developer is to obtain feedback from students to

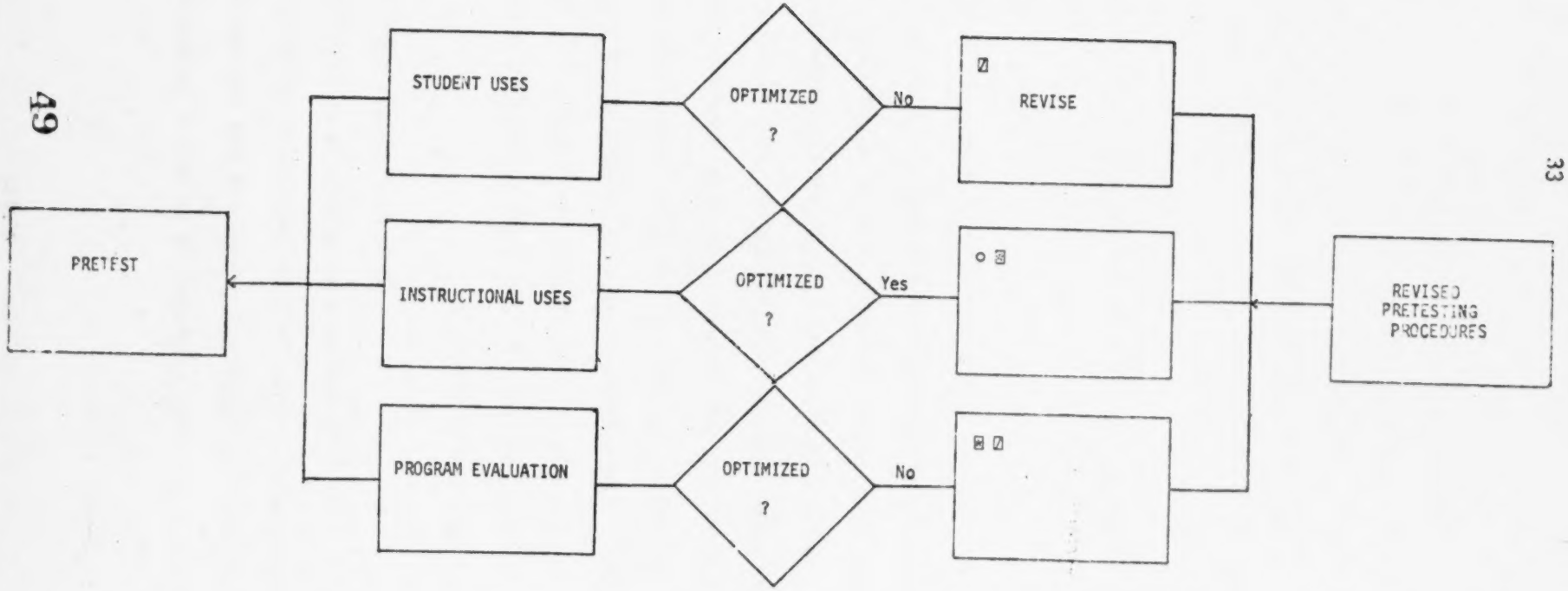


Figure 7.-- Flow chart of pretest procedures revision.

revise the course, the students must be encouraged to communicate their feelings and suggestions.

In the case of an unusual testing situation, a nongraded practice session should be scheduled. Careful explanation of course flow, instructional materials, the grading system, and the roles of the students and instructional personnel should provide the answers to many concerns before they are voiced; nevertheless, small groups should be used to encourage student questions. The instructor or technologist can then use the students' questions to improve the directions for the next group. Further, at the orientation session, students should be required to commit themselves to a date for the first evaluation session to avoid probable procrastination. Orientation revisions are principally in the type or detail of information presented to the student at the beginning of the course. Changes are based on student misunderstandings in a previous quarter or on revisions implemented for the current quarter. Orientation procedures revision are presented in Figure 8.

Operation of the Course

Operational procedures that are disliked by the students usually elicit much information. In addition, continuous monitoring by the educational technologist provides the data base. Because ways of alleviating problems are occasionally suggested, a proctor or the instructor should be available at all times to listen to discussions of problems as they occur. Examples of possible problem areas and changes are:

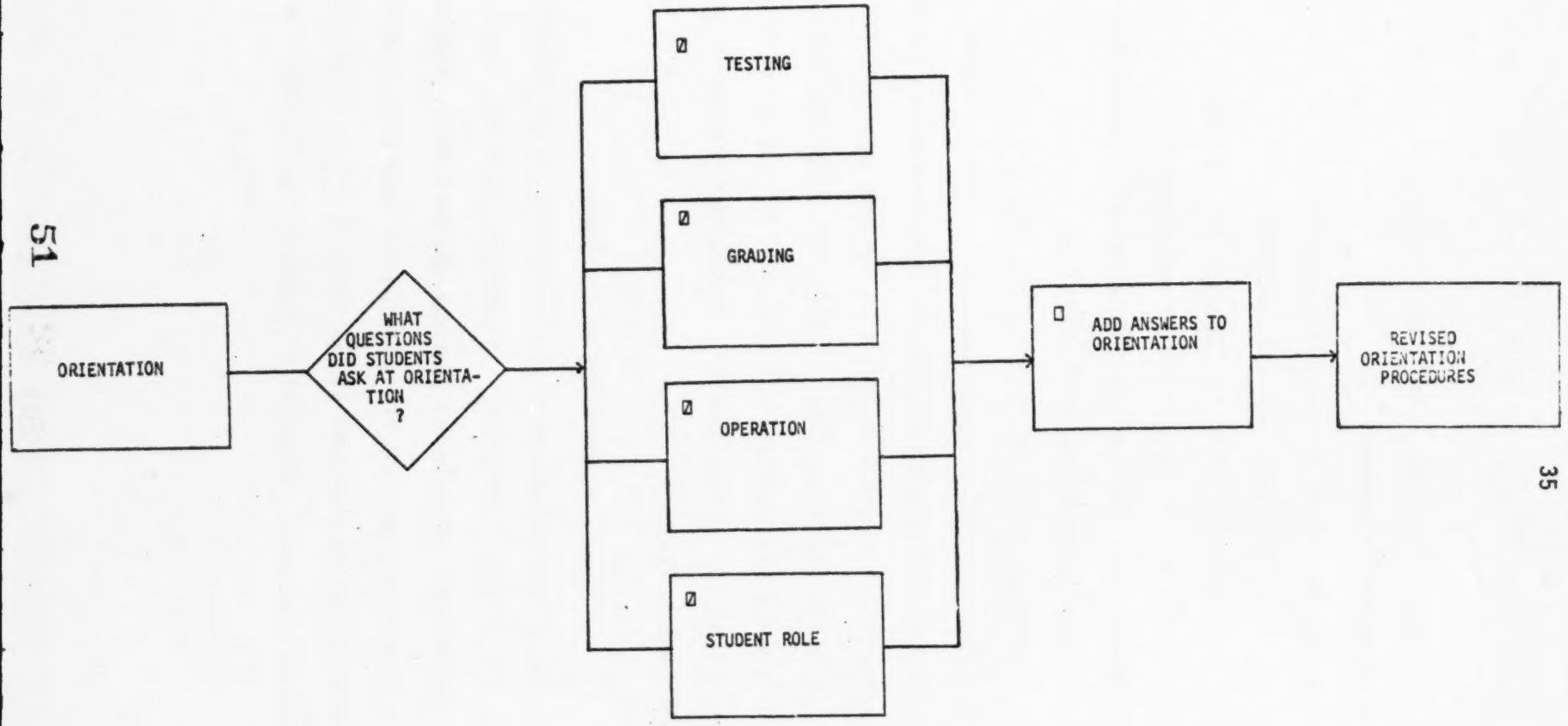


Figure 8.-- Flow chart of orientation procedures revision.

1. Changes can be made in class attendance rules.
2. Incentives can be offered to aid self-pacing by the students.
3. The instructor's role can be modified.
4. The structure of the discussion sessions can be altered.
5. Additional instructional feedback can be offered to the students.
6. Prescriptions can be added or elaborated.
7. An opportunity to repeat module tests for remediation or review for the final can be made available.
8. A means of presenting important messages to the students at times during the course can be provided.

Again the criterion is formal questioning at the end of the course. A flow chart of course operation procedures revision is presented in Figure 9.

Posttesting and grading

Criterion-referenced grading is generally unfamiliar to the students, who are accustomed to being graded on the normal curve. One type of revision would be an explanation of the grading system emphasizing how a grade of A, B, or C may be achieved. The rationale for grading standards can be justified by using a prior group's performance (Bloom et al., 1971), or the use of percentages that are familiar to students. Another type of revision could be in timing of the posttest. Both students' informal comments and experts' judgement would provide the data base. Solicited student comments should be used to evaluate the results of the changes. Flow charts of posttesting and grading procedures revision are presented in Figure 10.

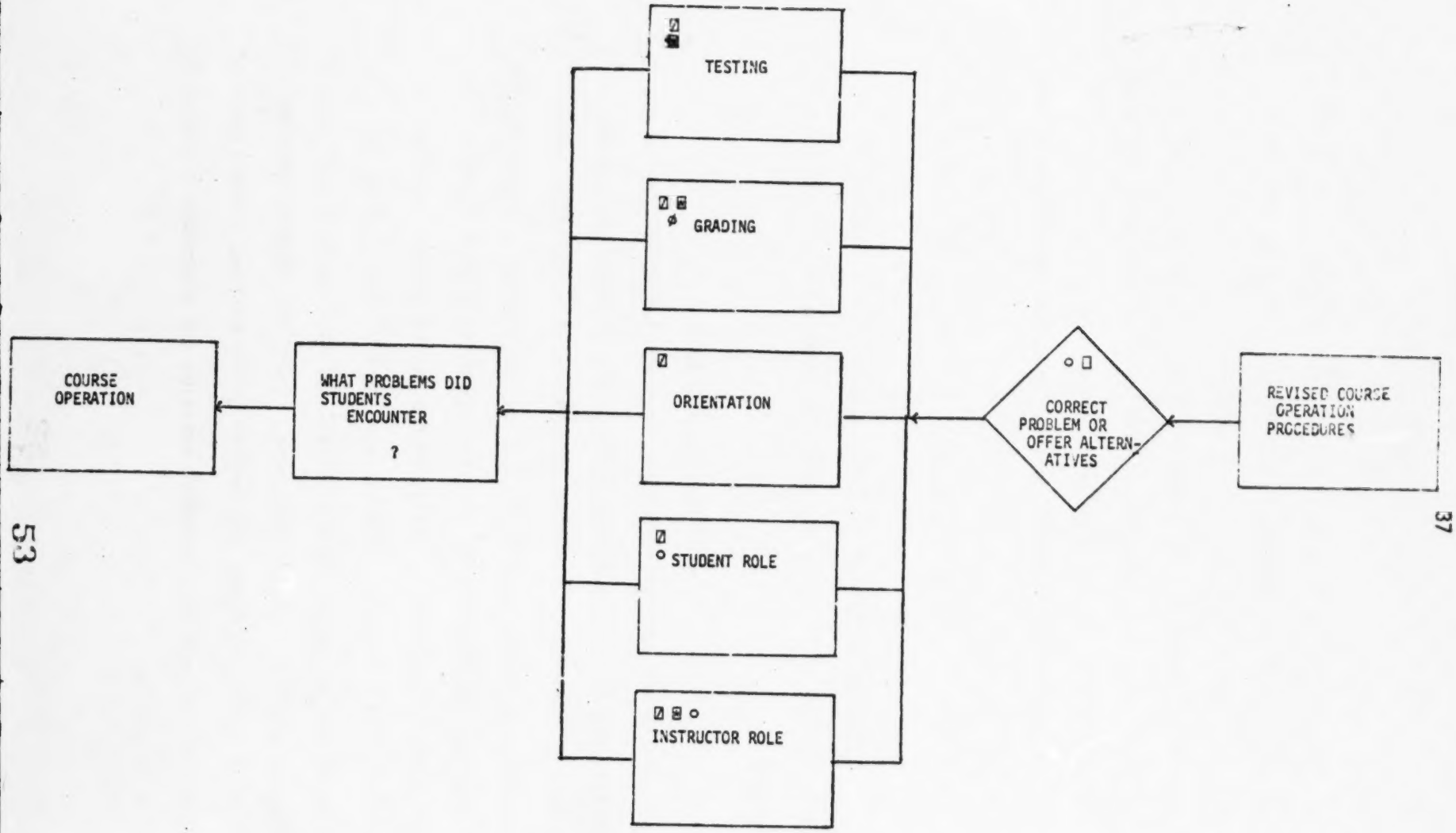


Figure 9.-- Flow chart of course operation procedures revision.

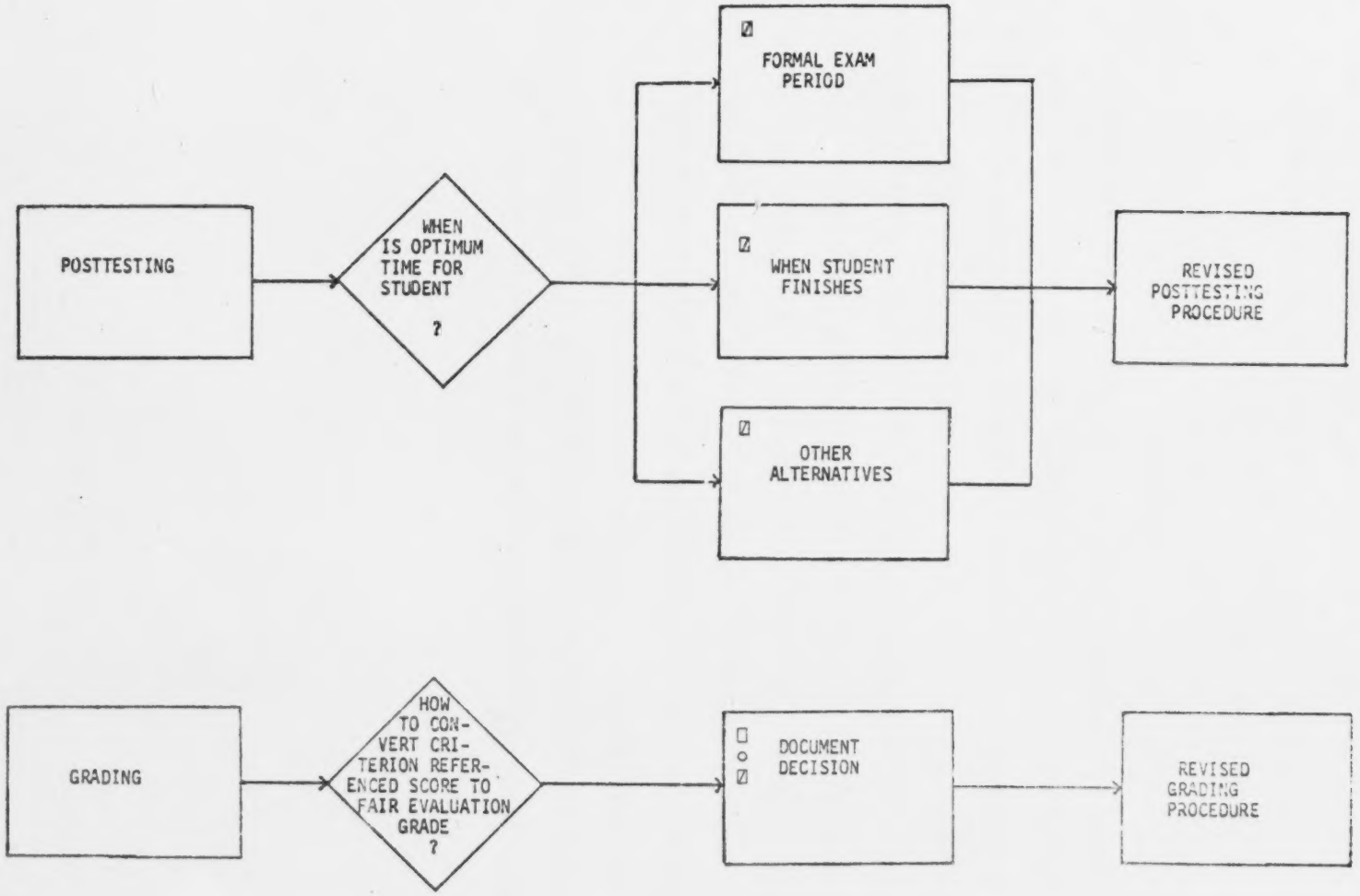


Figure 10.-- Flow chart of posttesting and grading procedures revision.

This chapter has described the principal components of a revision model. A definition of each component was accompanied by an indication of data that should be collected and the types of changes which can be made based upon the data.

Summary

As authors become more skillful at writing objective-based, criterion-referenced, learning units, some of the content revisions will become less necessary. But there should always be a review of a course from the point of view of student performance data and comments.

Also, as additional effective individualized courses are reported, the information may be used to perfect procedures, thus requiring fewer revisions. However, this model calls attention to the principal components of a course which should be considered for revisions. Revised procedures developed in one course may become models for another similar course. The model developed here is intended as an initial approach to a generalized revision model for courses developed by the systems approach. A summary of Figures 2 thru 10 is presented in Figure 11.

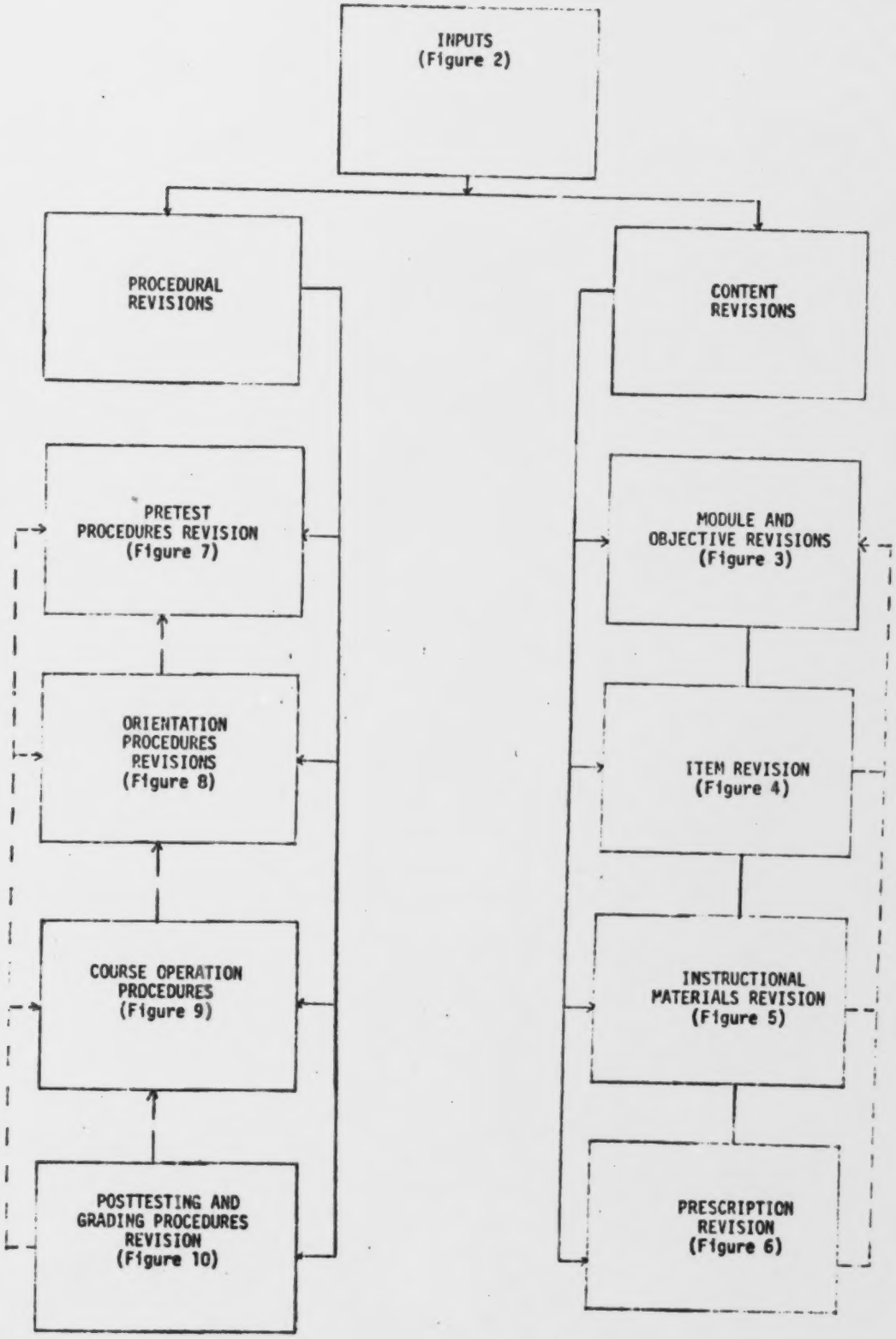


Figure 11.-- Summary flow chart of the Revision Model.

CHAPTER IV

METHODS AND PROCEDURES

This chapter is divided into three major topics. The first is a description of the development of the course according to systems approach methods. The materials developed and selected include the objectives, the remedial prescriptions, the student guide, the texts, the student digest, and the content and attitude measures. Second, a summary of the course implementation is presented. The final section describes the application of the revision model to the course based upon data obtained during its initial try-out.

A team, consisting of the course professor who served as the content expert, an educational technology professor who served as consultant, and two graduate students in educational technology, was organized in June, 1970, to develop an individualized, objectives-based, computer-managed course in health education for elementary education majors at Florida State University. The course was implemented in the fall quarter, 1970. Data collected in the fall were used as the basis for revisions, and the revised course was run in the winter quarter. During each quarter an experimental CMI group and a conventionally taught section were established. More detail is given in the course implementation portion of this chapter.

Materials

In order to implement this study via computer-managed instruction (CMI), the investigator cooperated with Dr. Marion Riser and Dr. Michael

Lawler in the conversion of Health Education 319, an undergraduate course required of all elementary education majors, to a CMI format. The curriculum for the fall quarter was divided into 14 modules, with a total of 32 objectives. Some of objectives are related to the teacher's direct instructional responsibilities, i.e., health-related information. An example of this type is the objective on the structure and function of the eye. "When presented with a description or a drawing of a human eye, the student can select the correct name for the parts." Other objectives are related to the teacher's supra-instructional responsibilities; activities not directly related to instruction. Examples of this type include: (a) the testing of vision and hearing; (b) observation of pupils for illness or abnormal behavior; (c) referral procedures; and (d) maintenance and use of health records.

The description that follows is of the materials as developed for the fall quarter. Revisions and rationale are presented in the winter quarter section of this chapter.

Modules

Every objective included in the course was presented in the framework of an instructional module, each of which included: (a) one or more objectives stated in terms of observable student behavior; (b) a sample test item for each objective; (c) reference to resource materials appropriate to the achievement of the performance objective; (d) a 10-item test on the objective, five items of which were selected randomly by the computer for each individual test; (e) a pretest made up of two items from the 10-item pool (See (d) above.) and two unique

items on the same objective. (The test was given to all students before they were given the objectives or study materials for the course.) and (f) a posttest, identical to the pretest, given upon completion of the course.

Student guide

Each student who took the course by CMI was given a course guide containing the following:

1. An introduction to the course.
2. Directions for signing on the computer.
3. A description of each of the 14 modules.

Each description included a statement of the objective in behavioral terms, followed by a sample test item, and the primary (required) readings, and secondary (supplementary) readings. (See example in Appendix A).

Instructional materials

The two textbooks required for the course were supplemented by articles and portions from other textbooks and periodicals. The primary references covered all the material needed to meet the objectives. The secondary references were supplementary.

All the readings which were not included in the textbooks were reproduced and bound to save students the inconvenience of looking them up. Copies of this student digest were on file in the library and were also available for purchase.

Evaluation instruments

During the treatment period, student posttest performance on each instructional module was recorded. Attitude, strategy, and information questionnaires were administered when the student had completed half of the instructional modules and again when he had completed the course. At the end of the quarter, a final examination was scheduled for all course sections. The same test that the students had taken as a pretest was administered as the final examination. A summary description of each measure is given below:

1. Pretest. Five alternate forms were used in the fall quarter. Each form contained two items from the computer item pool for each objective, and two additional items that were common to all five forms for each objective. All students took the pretest.

2. Module test. Five items were randomly selected by the computer from a 10-item pool for each objective. The student was tested on all objectives for a module at one time. Only CMI students took the module tests.

3. Midterms. Teacher-made tests were given to the traditional instruction group. The CMI group received no midterm examination.

4. Posttest. The posttest was identical to the pretest for each student.

Attitude measures

The students' reported attitudes toward CMI (See Appendix B) were measured by Brown's scale.

The students' Attitude toward Health Education (See Appendix C) were measured by an 18-item scale selected from scales reprinted by Shaw and Wright (1967).

Other measures

Student Strategy Questionnaire (Form A) (See Appendix D), which was given before the student took the course, asked him to characterize his typical studying strategy. Student Strategy Questionnaire (Form B) (Appendix E) was given during and at the end of the course, and asked the student to assess the strategy he used while taking HEE 319.

Reliability and validity of the measures

The course content embodied in the 14 modules for the fall quarter is representative of the standard undergraduate health education curriculum. This fact is attested to by an examination of any representative sample of health education textbooks. Dr. Marion Riser, associate professor of health education for 20 years, granted final approval on all decisions regarding course content.

Hoyt's internal consistency reliability, calculated for the attitude toward CMI measure (Appendix B), is .86, and is .84 for the Attitude toward Health Education (Appendix C) for the whole sample on the pretest.

The student strategy questionnaires (Appendices D and E) are exploratory.

Remedial prescriptions

Remedial prescriptions employed in the investigation for the fall quarter were presented on the cathode-ray tube CMI terminal.

Specifically, the corrective procedures entailed the re-examination of instructional material keyed to the failed objective. In addition, the prescriptions attempted either to clarify the objective or to focus the student's attention on the critical features of the resource material. A sample remedial prescription from the fall quarter is shown in Figure 12.

You failed to meet the passing criterion of 80 percent on objective 1. It is strongly recommended that you:

1. Reread the objective carefully.
2. Reread: Wheatley, pages 260-275.
   Take special note of the diagram on
   p. 270.

When you feel that you are prepared to retake this module posttest, you should reschedule terminal time at the CAI Center.

Figure 12.--Example of a remedial prescription as it appears on the CRT.

Course Implementation

During the summer (1970) quarter, the course objectives were developed, items were written, an algorithm for the computer management system was designed, appropriate readings were chosen, a student guide to the course was written, and instructional materials were duplicated.

The course was implemented in the fall quarter. One intact class was randomly chosen to be a control group and was taught in the traditional manner, while the remaining three sections were assigned to CMI. In the CMI sections, each student was randomly assigned to one of three treatments.

Students in the first group received a prescription if they failed to meet criterion (80 percent) on a module test, and further, had to repeat that module test until they did reach criterion, i.e., forced mastery. In the second group, students received a prescription if they failed to meet criterion on module tests, but were not permitted to repeat the test. In the third group, no prescriptions were given and no tests were repeated. Following the fall administration of the course, results were analyzed, and revisions were made for the winter quarter on the basis of the revision model.

The results of the fall administration of the course indicated that the pre- and post-attitude scale scores were the same for both CMI and conventional groups. The criterion score proposed for the winter of 80 percent (raw score = 73) on the final examination was reached by 17 students in the fall, which was 17 percent of the students in the CMI group.

During the winter quarter, students were given the revised course. The data base for revising the course was collected in the fall quarter, changes were made, then the revised course was implemented in the winter during which data to evaluate the revision process were collected.

The winter population consisted of the 135 students who enrolled in HEE 319 for the second quarter of the 1970-71 school year. Two sections, with a total of 73 students, were randomly selected to serve as intact classes which were taught in a traditional manner. The course was modified to the extent that these students were given the

student guide and the same pre- and posttest as the CMI group. The remaining 62 students were assigned to the CMI group.

The treatment period for this study was two successive quarters beginning in the fall of 1970 at Florida State University. For both quarters, at the first class meetings, pretest data were collected, treatments described, and a detailed explanation of the course given.

Based on the fall quarter results, the course was revised in order to maximize student achievement as measured by the criterion test. The process included both content and procedural revisions. Content revisions can be described as changes in specific features, such as items, objectives, and prescriptions. Procedural revisions are changes in the total way the course is conducted, such as procedures for assigning grades and requirements for class attendance. The former changes can be determined on more or less quantifiable data; the latter are relatively nonquantifiable.

Content Revisions

Content revisions were made in the six areas described in Chapter III: modules, objectives, diagnostic test items, pre-posttests, instructional materials, and remedial prescriptions.

Number of modules

Students in the fall quarter CMI sections expressed despair at the quantity and scope of material presented. It was decided that there had been an over-projection of the amount of material that should be required in a 10-week quarter. Since the modules on First Aid, Healthful Environment, and Consumer Health were not covered in

the fall quarter in the conventional class due to lack of time, it was the content specialists decision that they should be deleted from the course in the winter. The final list of modules may be found in Appendix F.

Objectives within modules

Based on feedback from the students and the professor as to the value or clarity of objectives, objectives were retained as they were, rewritten, replaced, or dropped. Appendix G contains a summary table of the fall quarter module and objective changes.

Items within objectives

Using item analyses, student comments, and revised objectives, each item was reviewed, and was retained, revised, or replaced according to a preset list of criteria. Seventy-five items were changed in some way for the winter in accordance with the rationale statement in Appendix H. The same item pool was used in the module tests as on the pre- and posttests with the exception of one randomly selected item for each objective that was unique to the pre- and posttests. Because of the general nature of the course content, some items testing "important" points could be answered from common knowledge. Therefore, many items were quite detailed. An item was not dropped for this reason unless there were many complaints. In general, only difficult, unimportant items generated feedback. Thirteen overly easy items were dropped; one was replaced; and two distractors were changed on another. Dropping easy items obviously tends to lower test scores; therefore, this revision technique tends to work against achieving a goal of higher test scores for more students.

Sixteen items were moved from the CMI pool to the unique pre-posttest; eight items were randomly selected for deletion to make all item pools equal in number; and six items were dropped because of complaints about their lack of importance. Other items were dropped because they were too similar, had more than one correct answer, or were inconsistent with objectives. Additional items had distractors added, dropped, or revised while others had stem revisions.

Posttest

If 60 percent or more of the students answered an item incorrectly on the posttest, the matching of references, objective, and item were studied. Such a high error rate indicates instructional rather than student failure. If an objective was rewritten, items were revised or replaced to match the objective. The item pool for each objective for the fall quarter consisted of a minimum of thirteen items: one sample item, two items unique to the pre- posttest, and ten items for the computer (which randomly chose five for each objective for each module test). Two of the ten items were assigned to the final. For the winter quarter there were eleven items in the pool, one sample item, nine computer items, and one item unique to the pre- posttest. There were enough too-obvious or too-unimportant items to permit two deletions for each objective. The fall quarter unique items were often the least well-written items. They were written after the ten were chosen for the computer. The winter unique item was randomly chosen from the total item pool in an effort to get a more representative sample. A summary table of all item changes showing the rationale is listed in Appendix H.

Prescriptions

All but one of the winter quarter prescriptions were revised, made more explicit, and expanded. Although there was no significant difference in performance in the fall between those students who received prescriptions and those that did not, it was felt that improved prescriptions might improve student gains. A summary table of prescription changes (showing type of changes) is given in Appendix I.

Procedural Revisions

Procedural revisions were implemented in both the experimental group and the teacher-taught group. The fall quarter CMI groups served as controls. Procedural revisions were made in five areas: pretesting, orientation, incourse operation, final examination and grading. Both groups were given the following instruments during the pretesting phase:

1. The Attitude toward Health Education Scale (Appendix C)
2. The content pretest
3. Student Strategy Questionnaire A (Appendix D)

CMI Groups

Pretesting

Students were instructed not to guess on the pretest as it would be used as a diagnostic instrument. Each student was advised of his pretest scores by module. Strategy suggestions were made by the proctor (See Appendix J). Students in the fall had not been given

pretest scores although they expressed an interest. It was thought a student could use his pretest scores to better allocate his study time.

Orientation

After a verbal explanation of the course and receipt of the student guide, each student was given his first appointment at the CAI Center to take a prototype module test on the system. This did not count on his grade but gave him a no-risk opportunity to become acquainted with the hardware and the manner of testing. An appointment to return was made at that time. In the fall, many students seemed to dread their first encounter with the computer and failed to make their first appointment until late in the quarter. The new orientation procedure insured that most students came to the CAI Center during the first full week of classes.

Incourse phase

Seven new procedures were instigated in the winter quarter after a review of fall procedures.

1. Attendance at an instructor-led midweek discussion was mandatory unless the student had reached criterion on the first attempt on the module tests covered by that week's session. Attendance had been voluntary in the fall quarter and from 0 to 5 students in each session took advantage of the discussion groups. Making attendance mandatory if the corresponding tests had not been passed was for remediation; making it mandatory if the corresponding tests had not been attempted was an attempt to force a minimum pace.

2. The subject of each midweek discussion session was specified in the guide. During the preceding quarter, the subject of discussion had been left up to the students. This change was necessitated by the mandatory attendance decision.

3. Students received their scores by objective at the end of each module. As in the fall, the correct answer was given when a student made an error. (No total was given in the fall and students expressed a desire to keep a record of their scores.)

4. As in the fall prescriptions were given on the CRT at the end of each module for each objective on which the student failed to reach criterion (80 percent). In addition, expanded written prescriptions were available. In the fall, prescriptions had been displayed only on the CRT and many students did not copy them down to use for further study. It was hoped that a printed prescription that could be carried away with the student would be more likely to be used.

5. In the winter quarter students were allowed to repeat a module test once for no credit. In the fall quarter, students in the group that was forced to repeat a failed module test complained about the repetition of a test, while students in the group that was not allowed to repeat a module test complained about not being allowed to repeat. It was hoped this change might improve attitudes toward CMI as well as performance.

6. Students were given the Attitude toward Health Education measure and the Attitude toward CMI measure at the completion of the fifth module. This was a change only inasmuch as the number of modules changed. In the fall, it was given after the seventh module.

7. A message frame was inserted in the program to be sure all students received important reminders or changes. Although there was a bulletin board in the fall quarter, students failed to look at it.

Final examination, grades, and debriefing

A limited number of changes were made in the evaluation procedures.

1. Students in the winter could take the posttest at any time during the first nine weeks of the quarter after they had completed all 11 modules; they were also given the attitude measures at that time. The lack of incentive for early course completion in the fall, in addition to the very heavy work load, resulted in virtually all students finishing during the last week.

2. Final grades were given according to total points earned on a basis similar to the fall quarter (with adjustments for the decrease in objectives). The weighing and cut-off points were clearly explained to the students in their guide. A 13-item extra credit short answer test was also given with the final examination, but is not a part of the analysis of the effectiveness of the revision process.

A principal concern of the fall quarter students had been in translating their module test scores into grades. An explanation in terms of percentages (90 percent and above = A; 80 percent to 90 percent = B; etc.) was given to the winter students at orientation as well as upon request during the administration of the course. It was possible for the student or the proctor to compute the letter grade at any time during the quarter. A complete description of the grading procedure may be found in Appendix K.

After the students had completed the posttest, they were questioned, orally and in writing, about their perceived value of the revisions which had been made in the course. The advantage of an interview was that the students could suggest other changes that might be made. On the written questionnaire the responses were necessarily restricted by the questions asked.

All the revisions listed above relate to the CMI course. In the process of working with the content expert, changes were also made in the conventional course to make it more compatible with the CMI course. The changes are described below.

Teacher-Instructed Group

The second group, to be consistent with the fall quarter, is indicated by the acronym CI; however, it is only conventional in that the students attend all regularly scheduled class sessions with a lecture format, and module tests are clustered into two mid-term examinations.

Orientation

The CI group received a guide which included the same objectives as those received by the CMI group. In the preceding quarter, the professor received the guide but the conventional mode students did not. It was hoped that prespecified subjects by dates would help pace this group.

Incourse phase

Midterm dates were specified in advance and items for the examination were selected from the computer item pool. The number

of items on all incourse exams equaled those for the total CMI module tests (115 items).

The mean score on the common final in the fall quarter was about 10 points lower for the teacher-instructed group than for the CMI group. It was hoped that midterm examinations made up of items from the same pool as the CMI tests would be more fair to the conventional group. The Attitude toward Health Education scale was given at the quarter mid-point to this group.

Final examination and grades

The final examination was given during examination week jointly with all CMI students who did not choose to take it early. The same prespecified grading system was applied. All students were given the Attitude Toward Health Education scale, the extra credit test, and debriefing questionnaire a the final examination.

The final grade was based on the weighted sums of a textbook evaluation, the midterms or module tests, plus the final. (A complete description of the grading procedures may be found in Appendix K.)

Debriefing

After the students had taken the final examination, they were questioned, in writing, about the usefulness of the revisions. On the questionnaire the students rated the usefulness of each procedural change.

All of the changes made in the course, both with regard to content and procedures, are summarized in Table 1.

Table 1.--Summary

Area	Changes made
	Content Component
Modules	Deleted three
Objectives	Deleted 2, reworded 9, added sentence to 2
Items	Deleted 40, moved 16 to unique pool, distractors changed 5, stem changed 1
Posttest	Reduced item pool from 13 to 11, reduced unique items to 1 per objective.
Prescriptions	Twenty-two prescriptions rewritten
	Procedural Component
Pretesting	Students were given feedback on their performance by objective with study suggestions.
Orientation	Students were given an appointment to be tested on a practice module during the first full week of classes.
Operation	Attendance was made mandatory at midweek prespecified discussion section unless student exempted. Students received scores at end of each module. Prescriptions were printed. Module tests were repeatable. A message frame was added.
Posttesting	Students could take the posttest at any time after completion of the 11 module tests.
Grading	The grading procedures were based on the results of the preceding quarter and announced to the students at the beginning of the course.

CHAPTER V

RESULTS

The presentation of the results of this investigation is organized into two main sections. The first of these pertains to the results of the revision in terms of changes in student performance. Total scores, module scores and scores by objectives as well as several other measures are reported. The second section contains the results of an analysis of the revision model itself, in terms of the effectiveness of specific revision techniques.

Since student performance in this study is the primary indication of effectiveness of the revision process, this section will cover overall student performance, attitudes, learning time, and student performance by module and by objective.

Overall Student Performance

CMI student performance was measured three times during each quarter, yielding the results illustrated graphically in Figure 13. The means and percent of students reaching the criterion of 80 percent performance are presented in Table 2. During the winter quarter, 0 percent of the CMI students reached the 80 percent criterion on the pretest, 27 percent on the summed module tests, and 71 percent on the posttest. For the fall group the same three measures were 0, 31, and 17 percent respectively.

TABLE 2.--Summary of means and percentages to reach criterion on all tests for fall and winter quarters.

Type of Test	$\bar{X}$	Possible Scores	Percent to reach 80% Criterion
Pretests			
Fall (all S's)	40.1	92	0
Winter (all S's)	33.5	92	0
Midterm-Module Tests			
Fall CMI	83.5	115	.31
Winter CI	82.6	115	.19
Winter CMI	86.1	115	.27
Posttests			
Fall CI	56.7	92	.02
Fall CMI	63.9	92	.17
Winter CI	70.2	92	.37
Winter CMI	75.8	92	.71

The pretest and posttest score distributions are illustrated in Figures 14 and 15 respectively. They show that, whereas the fall means (and score distribution) are higher on the pretest, the opposite is true on the posttest. That is, the fall means are higher than the winter means on the pretest and lower on the posttest.

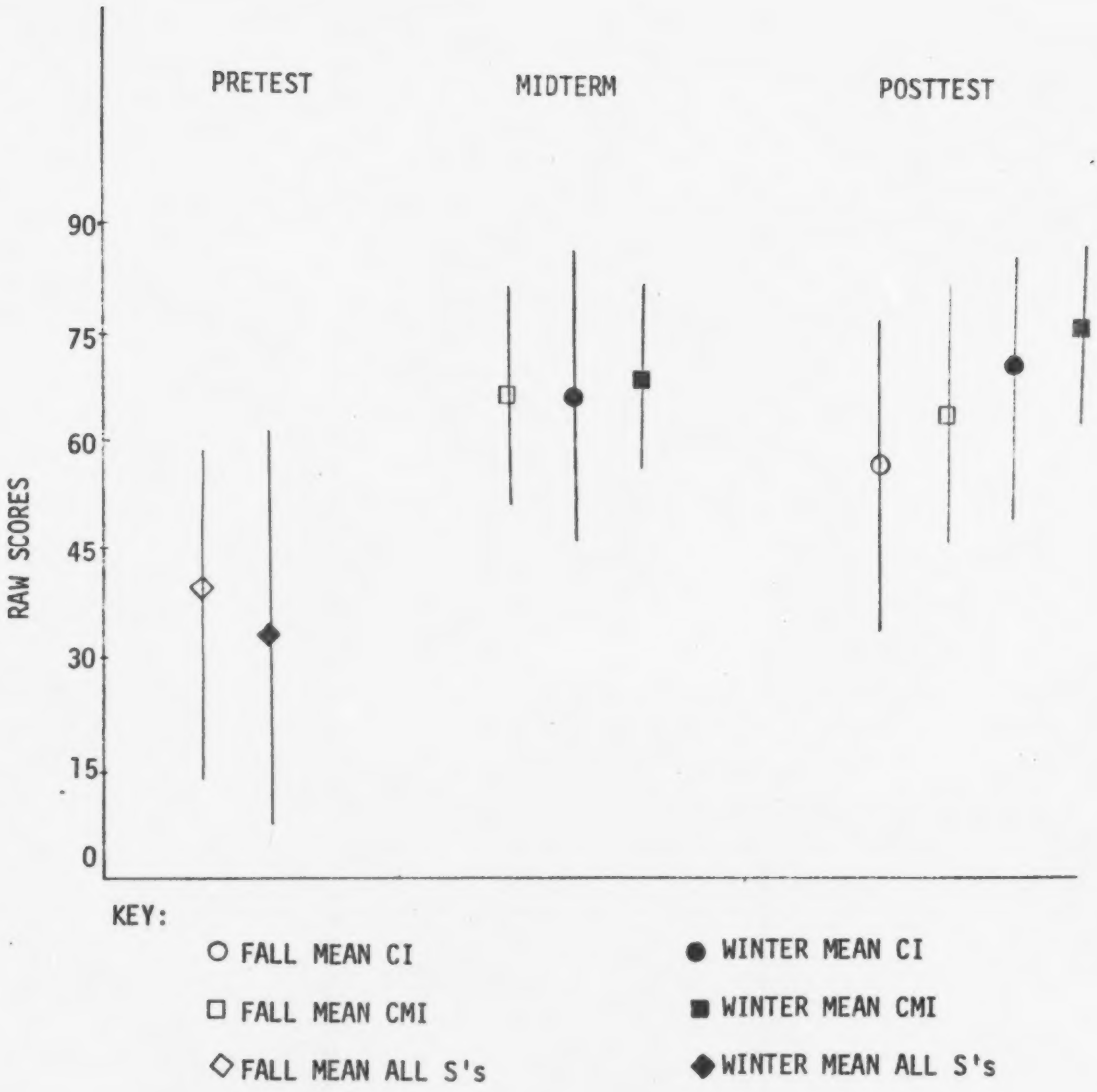


Figure 13.--Range and means of Fall and Winter Pretest, midterm and posttest for CI and CMI groups (Midterm adjusted to same number of items).

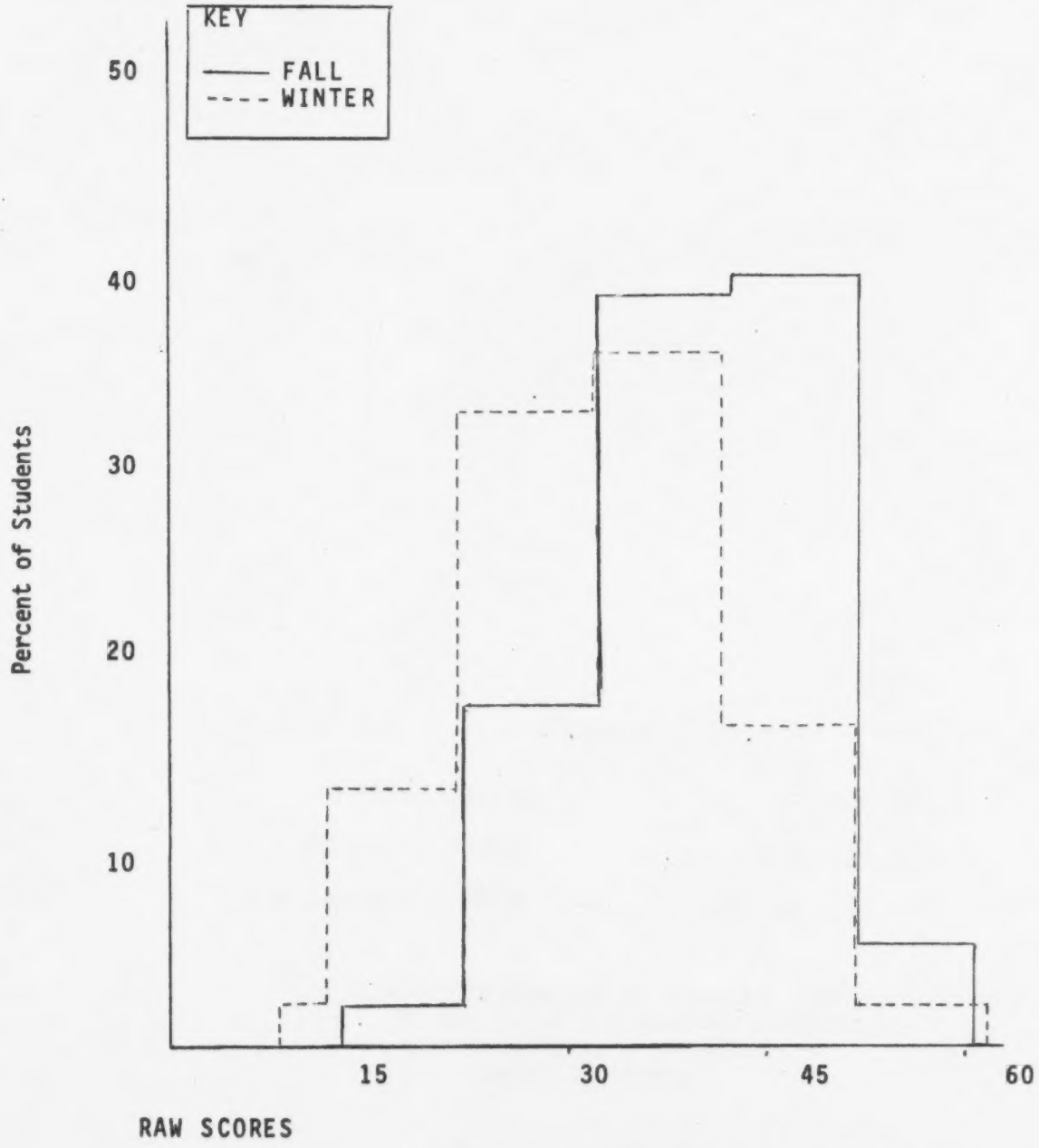


Figure 14.--Histogram of pretest results for all students for fall and winter.

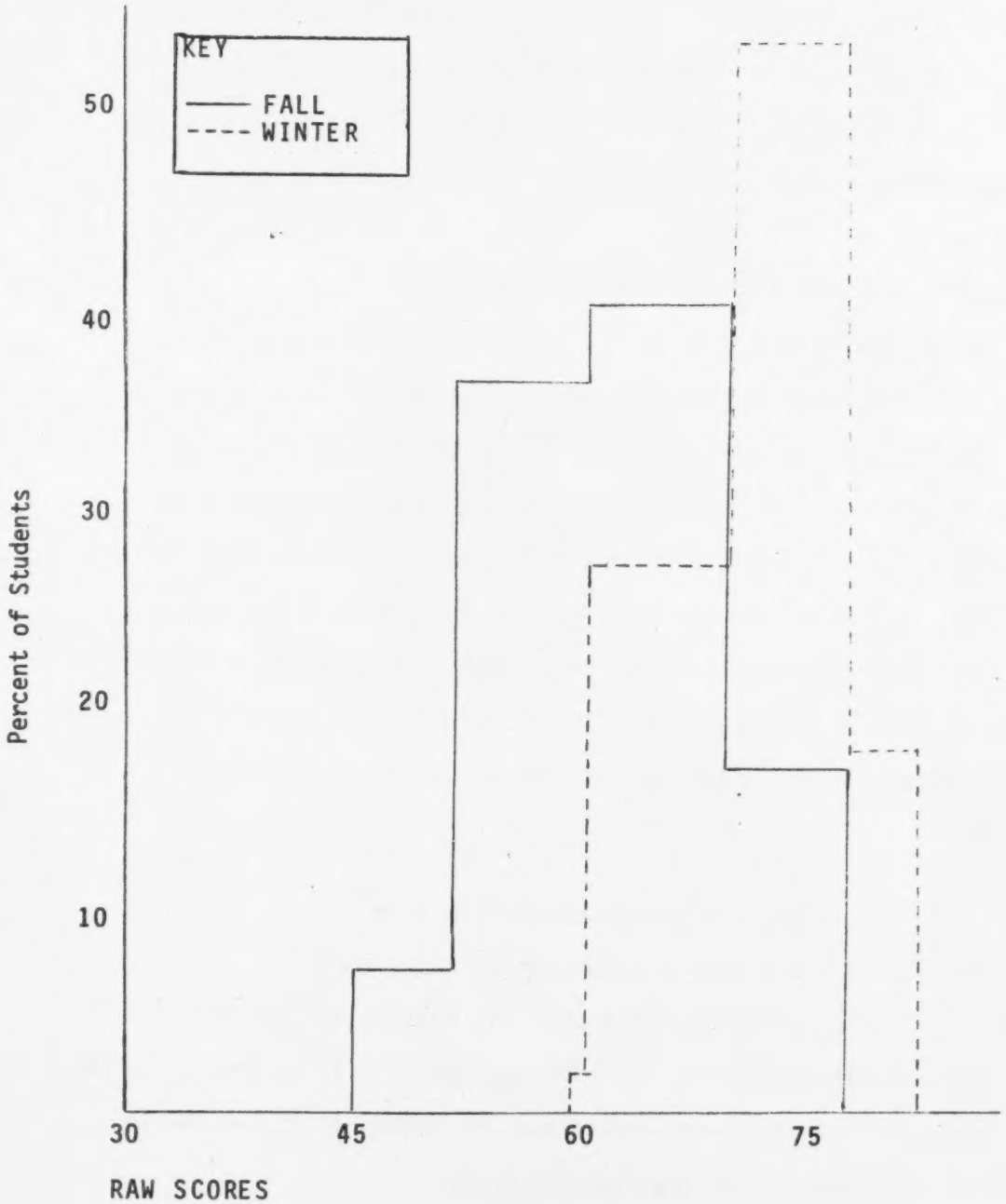


Figure 15.--Histogram of posttest results for CMI students for fall and winter quarters.

Means on the summed module tests for the CMI students rose from 83.5 to 86.1. The posttest means changed from 63.9 to 75.8 from the fall quarter to winter quarter. (A t-test was performed and the means were statistically significantly different at the .05 level.) In addition, as illustrated in Figure 16, the range decreased on each test from fall to winter. Results for the CI group are presented in these tables and figures, but are only for pre- and posttests as no comparable midterm was given to the fall CI group.

In the Lawler (1971) study (fall), a statistically significant difference was found between student performance on items drawn from the computer pool and items which appeared only on the pre- and posttests. Students averaged 69 percent on the familiar computer pool of 64 items, and 60 percent on an equal number of unique items. The proportion of unique items on the pre and posttests was cut from 50 to 25 percent of the test items in the winter; the total number of items was reduced from 128 to 92. For the winter quarter the mean for the computer items was 85 percent while the mean for the unique items was also 85 percent.

Fall and Winter Attitudinal Data

Student attitudes were assessed by two instruments: (a) Attitude Toward Health Education (see Appendix B), and (b) Attitude Toward Computer-Managed Instruction (see Appendix A). While the Debriefing Questionnaire may be considered attitudinal in nature, it is treated in the section on evaluation of revision techniques.

The attitude toward health education scale is made up of 17 items. Each item has a value of 1 to 5. A "1" indicates a negative

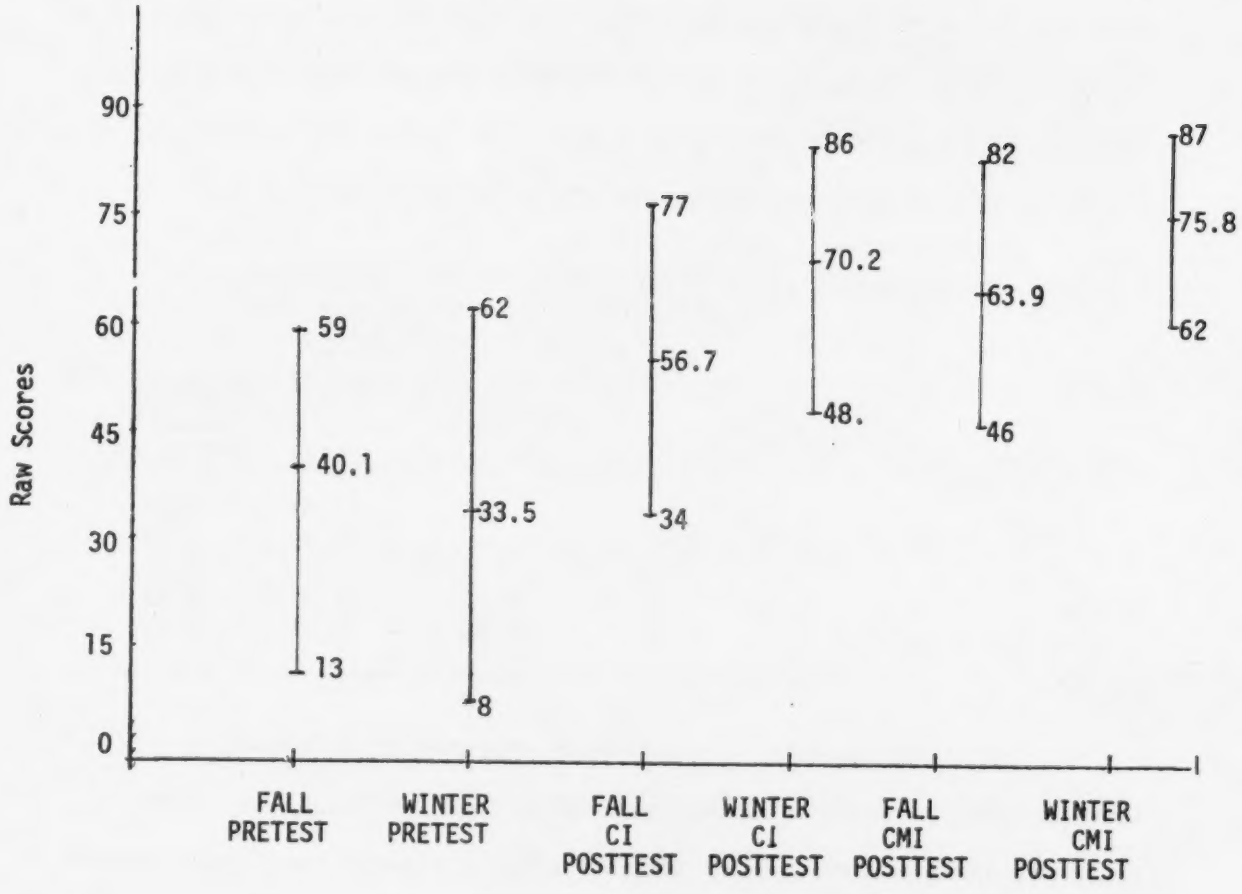


Figure 16.--Range and means for winter and fall CI and CMI pre- and posttests.

attitude and "5" a positive one. The highest possible score is 85 and the lowest is 17. A score of 68 is a positive score and one of 51 a neutral score.

The presentation here follows that of Lawler (1971) as fall student attitudes serve as the basis for comparison. No inferential analyses were performed since the means of the CMI students changed less than 3 percent from the fall quarter to the winter quarter, or during the quarter. The means and standard deviations are presented in Table 3.

Table 3.--Means and standard deviations of fall and winter CMI and CI groups for the pre, midterm, and final administration of the Attitude Toward Health Education.

		Pre Assessment		Midterm Assessment		Final Assessment	
Time	Group	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Fall	CMI	68.19	6.87	--	--	71.35	8.07
	CI	68.30	6.70	--	--	71.40	7.57
Winter	CMI	67.98	5.92	69.43	6.12	69.67	6.67
	CI	65.23	8.49	65.13	10.58	65.63	9.72

The second measure of attitude is represented by scores on the Attitude Toward Computer Managed Instruction Questionnaire. This scale was administered in both quarters after a student completed one-half of the modules and again after he completed all the modules. No real change is indicated as can be seen in Table 4. Eighteen students either did not complete both forms or incorrectly marked their answer sheets.

Table 4.--Means and standard deviations of fall and winter CMI groups at midterm and final administration of the Attitude Toward CMI.

	CMI	Midterm Assessment Mean	Midterm Assessment Standard Deviation	Final Assessment Mean	Final Assessment Standard Deviation	N
Fall	Forced Mastery Prescription	127.33	18.4	129.2	17.7	42
	Forced Progression-Prescription	124.61	19.7	126.3	17.8	46
	Forced Progression	127.07	17.9	129.0	18.5	38
Winter	Optional Progression Prescription	130.6	19.5	130.9	18.0	44

Time Data

Time was measured in two ways: average number of days to midterm and to course completion, and mean latencies (total time signed-on to the computer terminal, in minutes). The first of these indices is presented with the Lawler data in Table 5.

Table 5.--Mean number of days to completion of midterm and total course for the fall and winter CMI groups.

Group	N	Midterm Completion Mean	Course Completion Mean
Fall	126	29	45
Winter	62	39	49

In spite of the fact that the number of course objectives was reduced in the winter, from 32 to 23, the mean number of days to take the midterm and to complete the course increased.

The number of modules completed each week is graphically portrayed in Figure 17. Thirty-four percent of the tests were taken in the last week. Although not shown here, most repeat module tests also occurred in the last week of the course.

The other time measure was system latencies or time on the computer, which are presented in Table 6. Because of the reduction in the number of modules in the winter quarter, the fall latencies are correspondingly adjusted, i.e., (multiplied by 23/32).

Table 6.--Means and standard deviations of total latency (in minutes) for fall and winter CMI groups

Group	N	Mean	Standard Deviation
All fall CMI groups	126	214.3	166.5
All fall CMI groups adjusted by 23/32	126	149.3	
Remedial Prescription forced mastery-fall group adjusted by 23/32	42	183.47	82.49
Winter CMI (optional repeat)	62	171.90	82.49

Winter latencies were higher than adjusted fall latencies for all CMI groups combined, but slightly less than for the one fall group that was forced to repeat failed modules during the course. As has been mentioned before, the other fall CMI groups were not permitted to repeat modules.

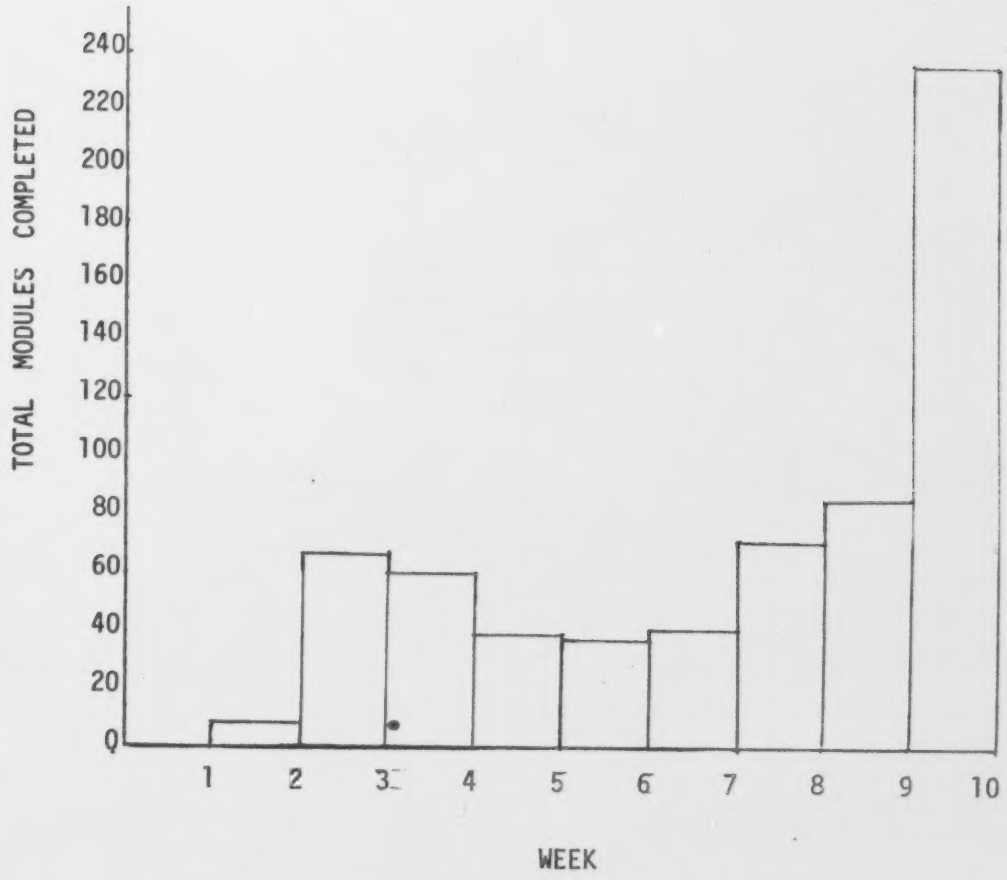


Figure 17.--Histogram of total number of modules completed by CMI students each week.

A somewhat different analysis indicates that when the students that reached criterion (80 percent posttest performance) are designated as "Yes", and those that did not as "No", it appears that a disproportionate percent (92 percent) of the high latency (above 200 minutes on the system) students are in the "yes" group. However, for the low latency group (50 to 100 minutes on the system) the percentage in the yes and no categories correspond almost exactly with the overall group. The middle latency group is the one in which a higher proportion of students are in the no group. Chi-squares analysis results are presented in Table 7.

Table 7.--Percentage of students in the "yes" and "no" groups by latency in minutes and x^2 values using totals as expected values

Latency	50 to 100		100 to 200		200 to 500		TOTAL	
	N	%	N	%	N	%	N	%
Reached Criterion								
YES	8	73	19	56	17	92	44	71
NO	3	27	14	44	1	8	18	29
	x^2 = .01		x^2 = 2.295		x^2 = 4.43			
Significance	N.S.		N.S.		*			

*Significant at .05 level. If one performed a simultaneous Bonferoni inequality, the critical value associated with the preset χ^2=.05 would not be exceeded and consequently would not be significant.

Student Performance by Modules

The posttest scores were also analyzed by modules. The original preset criterion of 80 percent for the subtests was difficult to

measure as the modules were represented on the test by either four, eight or twelve questions. (In order to use 80 percent as the criterion, there should have been five items per objective on the final test.) Therefore, for the analysis of all module subscores, the criterion was set at 75 percent. The means, ranges, and percent to reach criterion for each module on both fall and winter CMI posttests are graphically presented in Figure 18. For the fall quarter 80 percent or more of the students reached the 75 percent criterion on only one module, namely that on Growth, while the 80 percent or more goal was reached on 6 of the 11 modules by the winter students. Scores by module and percent to reach criterion for each module for the fall and winter are presented in Table 8. An increase in proportion reaching criterion is evident on all modules.

Table 8.--The percentage of students reaching the 75 percent module criterion on the posttest for fall and winter quarters.

Module	Fall	Winter
School Health	61	91*
Growth	83*	94*
Sex Education	47	82*
Mental Health	52	56
Vision	33	74
Hearing	63	83*
Mood Modifiers	42	68
Communicable Diseases	67	83*
Dental Health	39	79
Special Topics	46	73
Nutrition	58	33*

*Indicates 80 percent or more reached criterion.

Figure 18.--Range and means for CMI students' posttest scores by modules adjusted to 12 items and percentages to reach criterion for fall and winter.

1. The modules are abbreviated according to Appendix F.

The fall CI group did not have comparable midterms, did not receive objectives, and in other ways had a treatment so different from the winter CI group that gains might be exaggerated. Therefore, winter CI performance is compared principally to winter CMI. As is illustrated in Figures 15 and 19, the CI group did not do as well as the CMI group on the final or on any module tests.

Student Performance by Objectives

Scores, further subdivided by objectives, for fall and winter CMI groups on the posttest are presented in Appendix L. Eighty percent or more of the students reached the 75 percent criterion on only 4 of the 23 objective tests in the fall while criterion was reached by 80 percent or more of the students on 14 of the 23 objectives in the winter.

Student Strategy Questionnaire, Forms A and B

The last area which was analyzed was the relationship between individual differences in student learning styles and performance on the individualized course. Lawler (1971) found that students of different strategy "types" performed differentially on the final examination. In the present study, the students were classified according to their learning style and their ability to reach criterion on the final examination (the latter is referred to as "yes" and "no" in the tables that follow.)

Form A, a student strategy questionnaire (see Appendix D) given at the pretesting phase of the course and a similar one (Form B, see Appendix E) was given at the midpoint and the end of the course. Form A asked the student to describe his general learning strategy by selecting one of five strategy descriptions. Form B asked the student to select the strategy most like the one he used in this course.

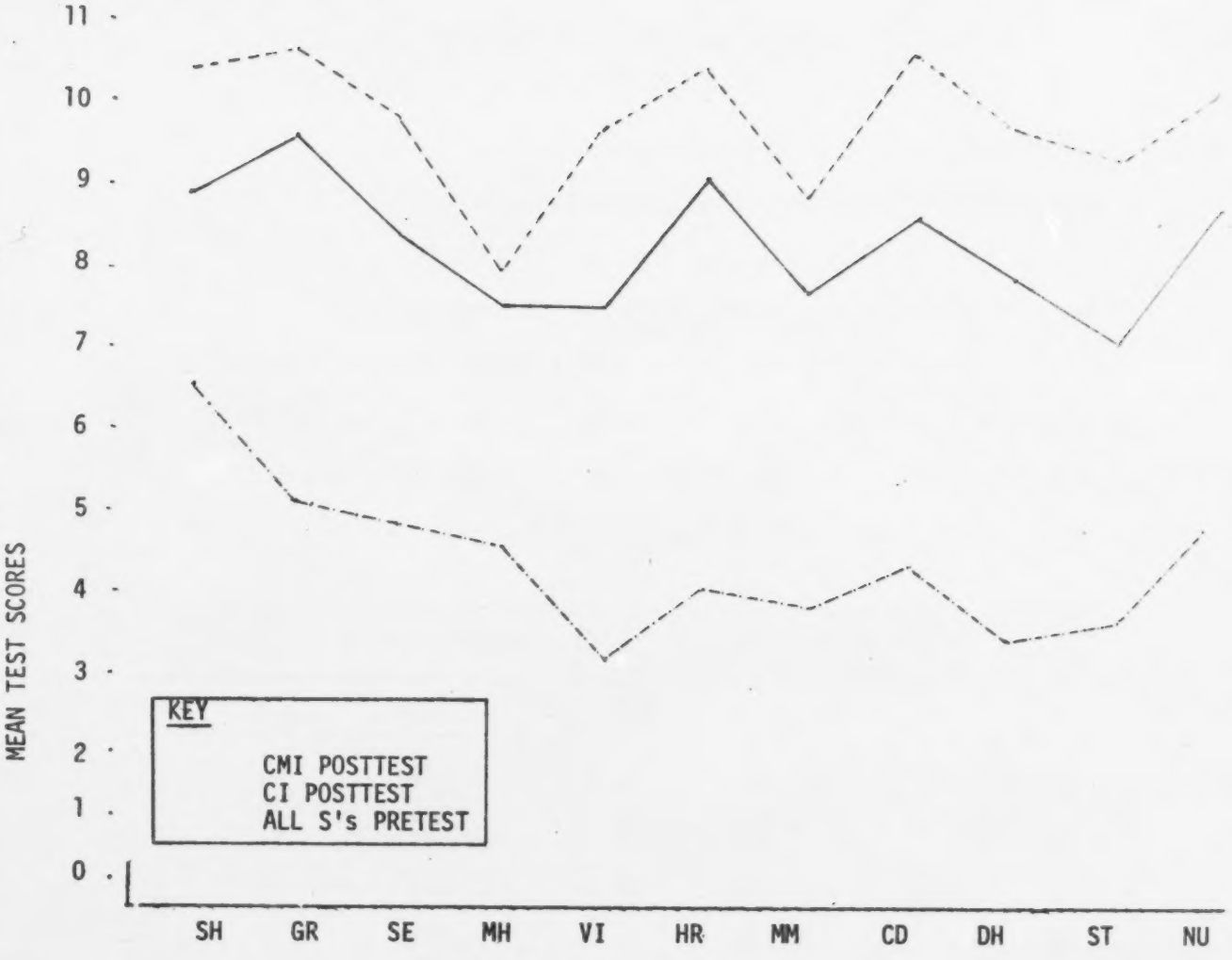


Figure 19.--Means for CMI and CI winter pretest and posttest scores by module adjusted to 12 items.

A brief description of each strategy follows:

Strategy 1: I am a procrastinator.

Strategy 2: I work at a steady pace.

Strategy 3: I study only what interests me.

Strategy 4: I study only what I do not already know.

Strategy 5: I study everything that is recommended.

As was the case in the Lawler (1971) study, students changed their self-reported strategies during the course. In Table 9 the percent of students in the "yes" and "no" groups that used each strategy, i.e., the end-of-course indication of their strategy, is presented.

Table 9.--The number of students by strategy on last administration and percentage that were above and below criterion.

	CMI			CI		
Strategy	N	%YES	%NO	N	%YES	%NO
1		82	18		35	65
2		94	6		69	31
3		50	50		33	67
4		28	72		25	75
5		60	40		30	70
Total		71	29		60	40

Using the treatment group ratio of those that did and did not reach criterion 71/29 for CMI and 40/60 for CI, as the expected values, a series of chi square analyses were performed. The results appear in Table 10.

Table 10.--Chi square values for CMI and CI groups that reached criterion for each of 5 strategies.

Strategy	N	CMI χ^2		N	CI χ^2	
1	16	3.898	*	29	1.041	N.S.
2	16	25.656	*	16	15.03	*
3	4	17.533	*	3	2.041	N.S.
4	7	89.858	*	12	8.375	*
5	15	5.876	*	10	4.27	*

* Indicates significance at the .05 level.

Lawler reported final examination means by strategies: means for CMI students with strategies 1 and 5 were about the same as the grand mean, those using strategies 3 and 4 were below, and those using strategy 2 were above the mean. For the winter quarter the results were highly similar. See Table 11 for the complete set of mean scores.

Table 11.--Means on final examination in percentages and gain over possible gain (G) for CMI students selecting the respective strategies as most typical on Student Strategy Questionnaire, Form B for fall and winter.

Most typical strategy	Fall	Winter	G
1	.67	.82	.45
2	.68	.87	.59
3	.63	.76	.35
4	.65	.75	.29
5	.66	.81	.44

One strategy not available to fall CMI students and not included in the questionnaire was the opportunity for one repetition of the CMI module tests. For analysis purposes, the students were grouped in terms of the number of modules they repeated: 0-5 repeated, 6-15 repeated, and 16 or over repeated. These were further divided into yes and no criterion groups. The numbers and percentages are shown in Table 12.

Table 12.--Numbers and percents of students choosing the three repeat strategies in the yes and no groups.

	Repeated 0-5		Repeated 6-15		Repeated 16 or over	
	N	%	N	%	N	%
No	14	23	4	6	0	--
Yes	19	31	19	31	6	10
Total	33	53	23	37	6	10

All who repeated more than 16 module tests reached or exceeded the 80 percent criterion level on the final examination. Of those who availed themselves of the opportunity to repeat at least 6 tests, 86 percent equaled or exceeded the 80 percent criterion. Possible implications of the strategy differences are covered in the discussion section.

Summary of the Data

The data have shown that there was a significant performance change from fall to winter with students using the revised course. The data described included: (1) The percent of students reaching the 80 percent criterion increased from 17 to 71 percent; (2) Attitudes toward both health education and toward CMI remained about the same; (3) The average number of days that students took to reach the halfway point and completion of the course increased; (4) Latencies, or time spent signed on the computer

to take module tests, increased; (5) The number of modules on which 80 percent of the students reached criterion increased from 1 to 6; (6) The number of objectives on which 80 percent of the students reached criterion increased from 4 to 14. Finally, (7) there was a difference in performance by students using different strategies.

The data have shown that student performance did improve after the revision model was applied. The second step of the analysis was an attempt to identify the content or procedural changes which might account for these differences.

Descriptive Results of Revision Techniques Applied

Two gain scores on objectives were calculated in order to derive a dependent measure upon which to evaluate various revision techniques. The first was the difference from fall to winter in the arithmetic average percent of students that answered the posttest (final examination) items correctly. For instance during fall the mean for the School Health module, objective 2 items was .73, while for the winter quarter, the mean for the items on this same objective was .86. The gain was .13, while the possible gain was .27, which equals a G of .48. The formula used (McGuiggan & Peters, 1965) is:

$$G = \frac{T_2 - T_1}{r - T_1}$$

Example: $G = \frac{.86 - .73}{1.00 - .73}$

$G = \frac{.13}{.27}$

$G = .48$

G= gain over possible gain

r= highest possible score

T_1= pretest score

T_2= posttest score

The pretest score (T_1) in this case is the fall posttest (before revision) and the posttest score (T_2) is the winter posttest (after revision). Table 13 gives a summary of the gain scores by objective. The second G score was computed using the gain in proportion of students reaching the 80 percent criterion. This second G score was used because of the original dual criteria of 80 percent of the students reaching 80 percent of mastery.

Explanation of Module and Objective Abreviations

Each module is represented by two capital letters, such as "SH" for school health, "GR" for growth and "MH" for mental health. The complete list of abreviations is given in Appendix F. Each objective within a module is designated by two digit numbers, such as SH01 for School Health module, Objective 1, and SH02 for Objective 2. Items within objectives are designated by two additional digits. For example, SH0101 would be the School Health module, Objective 1, Item 1, and GR0109 would be the Growth module, Objective 1, Item 9.

The eighty percent criterion was reached by 80 percent of the students on 3 objectives in the fall and on 15 in the winter. For purposes of analysis, the 23 objectives were analyzed in terms of the revision changes which were made. A short description of the types of content changes which were applied to the objectives is given in Table 14.

Table 13.--Posttest mean difficulty index by objectives for fall and winter and G.

Objective	Fall Mean	Winter Mean	Gain Over Possible Gain (G)
SH01	91*	87*	--
SH02	73	86*	48
SH03	77	84*	30
GR01	68	87*	59
SE01	73	78	12
SE02	72	78	18
SE03	73	85*	44
MH01	60	65	20
VI01	76	80*	17
VI02	76	81*	21
VI03	72	81*	32
HR0L	88*	92*	33
HR02	71	79	28
MM01	64	80*	44
MM02	64	75	25
CD01	69	82*	42
CD02	75	91*	64
DH01	78	84*	27
DH02	64	77	36
ST01	81*	86*	26
ST02	72	76	14
NU02	79	89*	48
NU03	67	78	27

* 80 PERCENT GOAL REACHED

Table 14.--Independent variables used in correlation tables with the abbreviation used to denote each one.

Positive Changes	Abbreviations for Change	Scoring System
Item Revisions		
1. Unique item changed	I-UNIQ	
2. Item revised	I-REV	number equals number of changes made.
3. Item replaced	I-REPL	
Guide Revisions		
4. Objective rewritten of made more explicit	G-OBJ	
5. Sample item	G-SI	number equals number of changes made.
6. References changed	G-REF	
Prescription Revisions		
7. Elaborated on the objective	P-OBJ	
8. Asked questions on the objective	P-QUES	0= not type of prescription 1= type of prescription
9. Paraphrased the questions used on the test	P-PARA	
Negative Change		
10. Number of items replaced because of being too easy	N-EASY	number indicates number of easy items replaced

Quantifiable Data

The types of revision which were quantifiable were grouped into four catagories, namely, improved items, improved student guide, improved prescription revisions, or item dropping. The first, item revisions, could be any or all of three kinds: (1) changing the unique item, (2) revising an item by changing the wording of the stem or the distractors, and (3) replacing an item completely. (See Table 14 for description of assignment of quantitative values to each type of revision). The second, guide revisions, could also be any or all of three kinds of changes: the objective in the guide could be rewritten, the sample item could be replaced, or the references could be changed in some way. The third kind, prescription revisions, could be only one of three types of changes. The written prescription could be changed to either an elaboration of the objective or to a set of questions on the objective, or a paraphrase of the item pool. The final type of content change concerned item changes but of a different type. It was the elimination of items that were too easy (an item difficulty index above .80 on the pretest). The data collected on an objective would look like: CD02 113 10 100 0. It would be interpreted as 1 unique item change, 1 item revised, 3 items replaced, objective rewritten, sample item replaced, references not changed, prescription of the first type, and no easy items dropped.

The correlation between the gain scores and the type of revision applied to each objective appears in Table 15. Only four correlations are significantly different from zero. Only one, a change in the sample item, correlates significantly with the gain score.

Table 15.--Intercorrelations of content revisions and correlation of revisions with G (actual gain/possible gain).

	VARIABLE NUMBER	1	2	3	4	5	6	7	8	9	10
	ITEM										
1	UNIQ	1.000	.080	.332	.188	.194	.332	.204	-.239*	.095	-.132
2	REV		1.000	.556*	.089	.324	-.009	-.079	.023	-.052	.190
3	REPL			1.000	.284	.394	-.294	.217	-.138	.022	.215
	GUIDE										
4	OBJ				1.000	.805*	.031	.424	-.235	-.225	.270
5	SI					1.000	.206	.316	-.216	-.126	.468*
6	REF						1.000	-.325	.095	.101	-.051
	PRES										
7	OBJ							1.000	-.683*	-.397	.154
8	QUES								1.000	-.271	-.116
9	PARA									1.000	-.086
10	SCORE GAIN/ POSS. GAIN										1.000

*r significant at .05
**See Table 14 for explanation of labels

Table 15.--Intercorrelations of content revisions made with gains in final exam score over possible gain.

A second type of gain score was computed by using proportion of students reaching the 80 percent criterion on the posttest during the fall to winter quarters, rather that the average student performance on each objective. These data appear in Table 16.

A second correlation matrix similar to that in Table 15, is presented in Table 17. Only five intercorrelations among the types of revisions were significantly different from zero, and only the change in the unique item was significantly correlated with the dependent variable. It should be noted that the two different gain score criteria were not correlated ($r = .13$).

It was the original intention of the investigator to use regression techniques to analyze the effectiveness of individual content revision procedures which were used in the study. However, with an "n" of 23 objectives on 10 types of changes, an R of approximately .80 must be obtained to be significantly different from zero. Because of the skewed distribution of both dependent variables (i.e., student performance and percent reaching criterion) regression analysis was not used due to the violation of the assumptions underlying that technique. Since the technique might be of interest in a more extensive study, the results have been included in Appendix M. Since currently available statistical techniques were not appropriate for the data, a clinical analysis of the results was performed. The first question asked was is there a difference in the types or numbers of revision techniques applied to those objectives that students reached criterion on and those that they did not.

In order to attempt to identify the most effective components of the content portion of the revision model, several descriptive analyses were made. Since there were dual criteria, the objectives for which revision

Table 16.--Gain-Over-Possible-Gain in Percent of Students to Reach Criterion by Objective for Fall to Winter.

Objective	Percent to Reach Criterion Fall	Winter	Gain	Gain Over Possible Gain (G)
SH01	96*	98*	02	50
SH02	70	90*	20	66
SH03	41	87*	46	78
GR01	83*	94*	09	53
SE01	77	85*	08	35
SE02	68	76	08	25
SE03	43	92*	49	86
MH01	52	56	04	08
VI01	64	74	10	38
VI02	41	85*	44	74
VI03	42	85*	43	74
HR01	66	90*	24	70
HR02	82*	79	-03	--
MM01	64	87*	23	64
MM02	52	65	13	27
CD01	70	79	09	30
CD02	36	81*	45	70
DH01	70	97*	27	90
DH02	36	76	40	62
ST01	79	94*	15	71
ST02	38	63	25	40
NU02	81*	79	-02	--
NU03	56	91*	35	79

*80 PERCENT GOAL REACHED

Table 17.--Intercorrelations of content revisions and correlation of revisions with G (actual gain/possible gain).

VARIABLE NUMBER		1	2	3	4	5	6	7	8	9	10	11
1	I-UNIQ	1.000	.122	.349	.214	.204	.349	.255	-.179	.116	.017	.495*
2	I-REV		1.000	.563*	.105	.329	.008	-.046	.043	-.039	.513*	.031
3	I-REPL			1.000	.293	.398	-.278	.234	-.120	.031	.258	.128
4	G-OBJ				1.000	.805*	.043	.436*	-.214	-.213	.079	.018
5	G-SI					1.000	.211	.322	-.204	-.120	.085	-.006
6	G-REF						1.000	-.294	.110	.109	-.190	.295
7	P-OBJ							1.000	-.633*	-.371	-.012	-.231
8	P-QUES								1.000	-.256	.183	-.094
9	P-PARA									1.000	-.304	.364
10	N-EASY										1.000	-.144
11	CRIT GAIN/ POSS. GAIN											1.000

was assumed to be effective were those which showed the highest G on both criteria. The six highest and six lowest are presented in matrix form in Table 18. There were 24 revisions made in the upper group and 23 in the lower group. Not only were the grand totals almost the same but so were the totals by type. (The column headings' numbers correspond to the same order listed in Table 14).

Because no distinguishing information was gained from that comparison, another analysis was made. The question was raised, if a second revision of the course was to be made, what system would be used. The decision would be to go through the same system again. No modules were changed and the focus was on items and objectives.

In the fall revision, only items with difficulty indices below .40 were thoroughly scrutinized. However since .80 was the original criterion established for each objective, the same criterion was extended to an analysis of all test items. A subjective evaluation of how well the information being tested was covered in the corresponding objective and the prescription was conducted. The evaluation consisted of the following ratings: excellent, good, fair, poor, and no relation between the item and the objective, the prescription, and the instructional material. A Chi square 2 by 2 contingency table was made by grouping the first three ratings and the last two and by arbitrarily dicotomizing the items into those above and below .65. The results pertaining to the relationship between the item and the statement of the objective are presented in Table 19.

Table 18.--Matrices of Revisions made.

Objective	Type of Revision										
	1	2	3	4	5	6	7	8	9	10	
Highest G's											
SH02		1							1		
SH03	1					1		1			
SE03	1	1	1				1			2	
VI03	1			1				1		2	
HR01	1						1				
CD02	1	1	1	1	1		1				
N	5	3	2	2	1	1	3	2	1	4	24
Lowest G's											
SE01								1			
SE02				1			1				
MH01	1	1	1				1			1	
VI01	1						1			1	
MM02	1		1	1			1			1	
ST02	1	1	1					1		3	
N	4	2	3	2	0	0	4	2	0	5	23

Table 19.--Chi square contingency table of ratings on how well items were covered by the corresponding objective.

Ratings	Difficulty level 65 and below	66-79
excellent good, or fair	13	24
poor or no	15	15

The hypothesis being tested is "Is the difficulty level lower on items that are covered poorly or not at all in the statement of the objective." The Chi-square obtained of 2.14 is significant at the .10 level for a one tailed test.

The same cutoff points were used to test the hypothesis "Is the difficulty level lower on items that are covered poorly or not at all in the prescription." The results are presented in Table 20.

Table 20.--Chi Square contingency table of ratings on how well items are covered by the corresponding prescription.

Ratings	Difficulty level	
excellent good or fair	18	27
poor or no	10	12

The chi square value obtained is .013, which is not significant at the .10 level.

The third question about the item's inclusion in the instructional material was checked by the content expert before the winter quarter. No ratings were made at that time.

Debriefing Questionnaire

In addition to these analytical procedures that were used to evaluate the effect of the content revision techniques, the students themselves were asked to evaluate both the content and procedural changes in the form of a debriefing questionnaire.

The CMI students were asked 19 questions (See Appendix N), and the CI students, 10 (See Appendix O). Additionally, both groups were asked to write comments on the back of the questionnaire. The questionnaire was attached to all finals, and completed by all but four students in each group. Five items on the questionnaire concerned content changes and twelve concerned procedural changes.

Content Changes

Modules

The first question asked about the amount of work required (course work load was approximately one-third lighter in the winter quarter). A majority of both groups reported that HEE 319 still required more reading and studying than most other three-hour courses. The percentages for both groups are reported in Table 21.

Table 21.--Module revision responses in percentages for CMI and CI groups: How was the amount of reading and studying required as compared to other three-hour courses

	CMI	CI
more ___	77	65
about the same ___	19	31
less ___	3	3
No response ___	1	0

Objectives

Answering the question on the statement of the instructional objectives in the guide (both groups received the student guide with the revised objectives), a majority of the CMI students found them "very helpful," while a majority of the CI students found them "of some help." The responses are included in Table 22.

Table 22.--Objective revision responses in percents for CMI and CI groups: How would you rate the objectives as stated in the guide?

	CMI	CI
very helpful ___	57	34
of some help ___	43	65
a handicap ___	0	1

Items

The majority of the CI group felt that the sample test items (two of which had been revised) were "of some help," while the CMI group was divided between "very helpful" and "of some help." A few in each group considered the items a handicap. The responses in percents are reported in Table 23.

Table 23.--Item revision responses in percents for CMI and CI groups: Rating of sample test items

	CMI	CI
very helpful ___	47	28
of some help ___	48	68
a handicap ___	5	3

Prescriptions

The next questions pertained to the prescriptive study sheets. The responses are summarized in Table 24.

Table 24.--Prescription revision responses in percents for CMI and CI groups: Use and helpfulness of study sheets

	CMI	CI
Did you use study sheet?		
not at all ___	16	10
some ___	53	26
a lot ___	31	63
No response	0	1
Helpfulness in studying for final examination material?		
not at all ___	3	10
some ___	52	29
a lot ___	34	60
No response	10	0

Ten percent or more of the students in each group did not use the prescriptions. Only a quarter of the CMI students used them a great deal, while over 60 percent of the CI students did.

In order to delve a little deeper into the students' attitude toward prescriptions, the students were then asked to evaluate these on helpfulness. Over 80 percent of each group found prescriptions either of some help, or a lot of help. Six of the students who had not used the prescriptions responded "not at all" (helpful) to this question, while two of them made no response. Three students who used prescriptions found them of no help. Two of the students who responded "not at all" to use of the study sheets, responded "some" to the question on helpfulness, one with the added comment "would have been."

Procedural Changes

The remaining questions were intended to assess student reactions to procedural changes in the course. No questions were asked about pretesting as the only change made was in offering the students their scores by module with study suggestions. Almost no students picked up this information.

Orientation

An innovation for the winter CMI students was adding a trial "no credit" (therefore no threat) module. The First Aid module was chosen for this purpose because most of the fall students had reached criterion on it on their first attempt. Eighty-eight percent of the winter students said that the trial module helped them a little. The complete responses are shown in Table 25.

Table 25.--Orientation revision responses to item 6 in percents for CMI group: The trial module (First Aid) on the computer was intended to bring you to the center and make you comfortable with the computer. Did it achieve that for you?

	CMI
made me never want to come back	3
no help at all	9
helped me a little	88

Operation

Eight of the debriefing questions concerned changes in the operation of the course. The responses are included in Table 26. Each item is discussed using the number associated with it in Appendix N.

Table 26.--Operation revision responses to items in percents for CMI for all questions and CI group where appropriate.

4. Helpfulness for final examination of being scored by objective?

	CMI	CI
very helpful ___	71	57
a little helpful ___	24	29
no help ___	5	10

5. Frequency of obtaining "study sheets" from the proctor when you didn't meet criterion on an objective

	CMI	CI
rarely, if ever ___	14	--
sometimes ___	24	--
always ___	62	100

8. Frequency of repetition of module tests

	CMI
none ___	31
some ___	14
many ___	19
all of them ___	56

9. Helpfulness in preparing for the final of repetition of module tests

	CMI
not at all ___	11
some ___	16
a lot ___	73

10. Effect of instant error correction on the module tests on the nerves

	CMI
none at all ___	17
some ___	55
very much ___	28

11. Helpfulness of instant error correction on the module tests

	CMI
not at all ___	2
some ___	45
very much so ___	53

13. Frequency of attendance at the weekly discussion session

	CMI
never ___	10
1 to 3 times ___	12
4 to 7 times ___	43
everytime ___	34

Table 26.--Operation revisions responses to items in percents for CMI for all questions and CI group where appropriate. (Continued)

14. Helpfulness of the human interaction in the discussion sessions.	CMI
not at all	14
a little	55
very much	26
no response	5

Item 4. In the fall CMI students received instant feedback, item by item, on incorrect answers at the computer terminal, but each student was expected to keep track of his own total score. A student in the prescription group was informed if he failed to reach criterion on any objective upon his completion of a total module. Winter CMI students were given scores by objective, whether they needed a prescription or not. After each midterm, each CI student was given a card with not only his total score, but also his scores by objective. In general, the CMI group found this more helpful than did the CI group. (Table 24).

Item 5. At the end of the on-line prescription on the terminal, students were told to pick up a "study-sheet" for each objective on which they failed to reach criterion. Most of them either picked up the sheets voluntarily or were given them at periodic meetings with the proctor. All CI students received study sheets with their midterm scores. The responses to item 5 substantiate the fact that not all students took advantage of this aspect of the course.

Item 8. In the fall only members of the forced mastery group were permitted to preat module tests, and then only when a student failed to

reach criterion on at least one objective. When repeating module tests was made optional for the winter quarter, one-third of the students reported that they repeated no modules while a little over a third repeated all of the tests. This is confirmed on direct examination of the output provided by the CMI data management system.

Item 9. In evaluating the helpfulness of repeating the module tests, half of the CMI students responded "a lot," while 9 percent responded "not at all." Examination of the responses of only those students who did actually repeat the tests shows that those figures are 73 percent and 11 percent, respectively.

Item 10. During the winter some CMI students complained that instant error correction on the CRT made them so nervous that they had difficulty completing the tests. (The CI students complained even more loudly that instant error correction gave the CMI students a distinct advantage.) Over 80 percent of the CMI students reported that it did make them nervous.

Item 11. However, when asked whether error correction was of some help, 98 percent responded that it was.

Item 13. During the fall, optional weekly discussion sessions were held but these were poorly attended. It was decided that during the winter quarter the discussion session attendance would be mandatory unless the student had not only completed, but also reached criterion, on the test for the module scheduled for that week. About three-quarters of the students attended four or more of the eight sessions.

Item 14. One of the reasons for making the discussion session mandatory was that the fall students who failed to attend the voluntary sessions said that they missed interacting with the professor. In the winter, with the new attendance requirement, three-quarters of the students found the sessions helpful.

The next three questions deal with the final examination and the grading procedures. The first question was appropriate for CMI students only. The remaining two were asked of all students.

Final Examination

Since the CMI students were self-paced, they were given the option of taking the final examination whenever they finished all the module tests. Although only seven students actually availed themselves of this opportunity, about 90 percent liked the idea as the data in Table 27 indicate.

Table 27.--Posttesting revision responses to item in percents for CMI group: Did you like having the opportunity to take the final early if you wished?

	CMI
yes, and I took it early___	12
yes, and I wish I had taken it early___	28
yes, but I needed the extra time to study___	52
no___	9

Grading

Fall CMI students expressed concern about their grades. At no time could the proctor or the professor tell them what letter grade to

assign to the test scores which they were receiving on the computer. Based on the fall cutting scores, the winter grading system was described in the Student Guide. Over three quarters of the CMI students responded positively to this plan, but only one-quarter of the CI students did. Responses are reported in Table 28.

This course was probably one of the few for the students in which grading was criterion referenced. The next question was intended to find out how they felt about criterion-referenced grading.

The responses varied considerably between groups. Seventy percent of CMI students liked it at least a little whereas almost sixty percent of CI students responded "not at all." Table 28 contains the percentages for both groups.

Table 28.--Grading revision responses to items in percents for CMI and CI groups.

Did you like the idea of having the grading plan spelled out at the beginning of the course?	CMI	CI
yes ___	79	26
a little ___	14	31
not at all ___	7	41
Did you like being graded on what you did rather than being graded on a curve?	**CMI**	**CI**
not at all ___	26	57
a little ___	31	28
yes ___	41	13
No response	2	1

The last item requested the students to write any additional comments on the back of the sheet. Thirty-two students responded with at least a short comment. A summary of these comments follows.

Free Responses

Sixteen CMI students made "free responses" on the debriefing questionnaire. Some comments were favorable: "good program," "worthwhile and constructive method of teaching," "computer organizes you and prepares you for the final," and "I liked knowing right away if my answers were right or wrong." Many had specific criticisms such as stating a preference for curved grading, needing more time available at the CAI Center, or that too much material was presented. And some were very negative, such as: "I hate the computer method." "The questions were irrelevent, confusing, and evasive." A most interesting one was: "Individual study courses are not my bag. I liked being able to do work whenever I wanted, but I didn't like the feeling of helplessness when I had to take all 11 modules two days before the deadline."

More uniformity was found in CI students' free responses typified by the following: ". . . It is not fair for us to be compared to the (CMI) kids. They have a definite advantage over our class in that they see more questions, have more tests (which doesn't put so much weight on each of their tests, and they can see the right answers to the questions thereby giving them a greater advantage for review.) . . It is grossly unfair to have our questions picked from a computer (a thing that doesn't know what was actually covered in class nor the emphasis on the topics)."

Summary

Several techniques were used to identify the content and procedural changes that might account for the improvement in student performance.

In the first, gain scores (G's) were correlated with the revisions made. The second was an attempt to find differing revision patterns in objectives that were successful and those that were not. Neither yielded useful information. The third, a hypothetical second revision cycle using more stringent criteria for items and reviewing the match between items and the corresponding objectives and prescriptions identified areas that needed further revision. A chi-square analysis showed some relationship between item scores on items that are covered well in the objective and those that are not. The fourth process used was collecting information on student reaction to changes made. Most changes were rated of "some help" or very "helpful."

CHAPTER VI

DISCUSSION

The primary purpose of this study was to design, develop, and empirically test a revision component for a generalized systems model. The effectiveness of the model has been demonstrated in the improvement of student performance. Three criteria were listed in the first chapter of this document for determining the effectiveness of the model:

1. How effective was the sum of the revisions with respect to a preset goal of 80 percent mastery for 80 percent of the students for the entire course? On the fall posttest, 17 percent of the students reached the 80 percent criterion; on the winter posttest, 71 percent reached 80 percent. Although less than the original goal, it was a considerable increase.

2. How effective was the sum of the revisions with respect to a preset goal of 75 percent mastery for 80 percent of the students for each module? In the fall, the criterion was reached on 1 module; in the winter it was reached on 6 modules. Although it is an improvement, it is far short of the 11 total modules.

3. How effective was the sum of the revisions with respect to a preset goal of 75 percent mastery for 80 percent of the students for each objective? Again, the improvement was good - from 4 in the fall to 14 in the winter, but the goal was not reached. Of the 9 objectives for which the 80 percent goal was not reached, 5 of them were over 75 percent.

Additional data were collected to answer related questions:

1. What was the total effect of revisions on student learning time and attitudes? The times measured were the amount of time a student was signed on to the computer, and how rapidly he progressed through the course. Permitting students to repeat tests raised the average latency by about 15 percent over the preceding quarter. But more interesting was the slower pace through the tests despite the lighter work load. In the fall, the average student completed 7 modules, the halfway point, in the first 29 days. In the winter, the average student completed only 5 modules, the halfway point, in the first 39 days. It appears that decreasing the amount of material slowed the students down.

Attitudes were measured toward health education and toward CMI. Despite the considerable improvement in posttest scores, neither attitude toward health education nor attitude toward CMI showed any change. Further, there is no basis for believing that additional revisions will improve attitudes. Few hypotheses can be drawn from measures of attitudes in experimental or developmental courses because no comparative data are collected on students from the same population in other, more conventional, classes.

Attitudes toward health education differed only minimally between fall and winter, pre and post, CI and CMI. Plausible explanations are both the insensitivity of the measuring instrument and an already crystalized attitude on the part of the students. It is possible that by the time a student reaches college age his feelings toward a subject area are fairly fixed.

The same explanations could account for the attitudes toward CMI. The principal intention of the model is to improve student performance through revision. If the principal intention were to change attitudes, save student time or some other goal, a somewhat different set of revision rules would apply.

2. What were the effects of revisions on the modified conventional class? The winter CI group did less well on all module tests than did the CMI group, but they improved considerably from the fall CI group. The fall CI posttest mean was 56.7 and the winter one was 70.2. The majority of the CI group, as reported in the debriefing questionnaire, preferred the conventional class situation; but they felt they were at a disadvantage to the CMI group as they received no item feedback and no test reviews. Both problems probably contributed to the lower final examination scores, but not to the lower midterm scores. A partial explanation may be that the CI group took half the module tests at each of two times, and that the focus of their studying was probably on what was emphasized in class rather than on the objectives stated in the guide.

It is clear that the addition of most of the elements of the "CMI system" to the teacher led class resulted in a major increase in student performance for that group.

3. Are there individual differences in the selected student learning styles investigated to which individualized instructional systems should be adapted? Although data on many variables were collected, during the two quarters, such as: selected variables in the Personality Research Form, grade point average, entrance examination scores, attendance at a junior

college, preceding health education courses, and information questionnaires, nothing proved very useful in predicting performance nor attitude. The one interesting difference was in the strategies reported. The results are so similar to those reported by Lawler (1971) and so decisively in favor of strategy 2 (completes work at a steady, consistent rate) that it is difficult not to believe that there is some merit in that strategy. By the same token, strategies 3 and 4 (studies only topics of interest and studies only topics on which prior knowledge is unsatisfactory) appear to put the user at a disadvantage. After further investigation, perhaps an additional procedural revision would be one that required students to use strategy 2.

In addition, a strategy not mentioned on the questionnaire nor permitted by the rules set up for the students was one of repeating the module tests more than one time. All 6 students that did the extra repeating reached criterion. Much of their success is attributable to item learning, but in order to reach 80 percent they had to get at least 4 unique items correct.

4. Based on the results of the implementation of the revision model, what changes should be made in the model? Conforming to the previous format, the changes are suggested for the two major areas of content and procedural revisions.

The principal content change in the model is the setting of a more stringent criterion for item revision. If the overall goal is 80 percent mastery, then the item with a posttest difficulty level below 80 percent should be reviewed for ambiguity, isomorphism with the objective, clarity of related instructional material, coverage

in the prescription, and comments especially solicited from students who missed the item in question.

The procedural changes were more difficult to measure, and to use effectively. While you can quantify students perceptions to various procedures, it is almost impossible to relate any particular procedure to a change in student performance. Since all objectives were equally affected by procedural changes, only the students' comments and the debriefing questionnaire were available for evaluating them. No formal data base had been collected in the previous quarter, but many of the changes were made becausee of informal students comments. Students were almost unanimous in saying that they liked the idea of being able to take the final test early, but since only 11 percent availed themselves of the opportunity, it probably had little effect on test performance. Similarly, they liked the preset grading standards; although that may have made them happier, it too probably had little effect on performance.

A "free" trial module was scheduled the first week of the quarter to bring all students to the CAI Center and encourage them to start taking module tests. They did come, and half felt it was helpful. However, in spite of this change and a decrease in the work load, students took longer to complete the work.

Most students used the study sheets and found them helpful. Since they were derived from the test questions, they should have been. Again, only a third used them "a lot." The one quantifiable procedural change was the opportunity to repeat module tests one time. Half of the students used the opportunity and of those that did, 86 percent reached criterion. Of all the procedural changes, this may have made the single greatest contribution to score improvement. The fall and winter CMI groups did not

differ on the midterm or module tests; but the winter group did considerably better on the final examination. The change took place between the first attempt at the module tests and the final examination. Both the receipt of revised prescriptions and the opportunity to repeat module tests occur during this period of time. Everyone received the prescriptions, but of those who repeated the module tests, a greater proportion reached the criterion.

The data derived from the analyses of the revision model clearly indicate there was a significant, positive change in student performance. However, problems develop when one attempts to isolate those components of the model which are most effective. The model itself creates this problem, since its purpose is to correct deficiencies in each instructional unit, which leads to a highly selective application of techniques. Each objective has a unique set of deficiencies and presumably correcting that unique set is the way to maximize student gain. An appropriate analogy might be the repairing of an automobile. Identifying that a problem exists in the electrical system is only half the battle. Not only does the exact cause or combination of causes have to be pin-pointed, but the mechanic needs certain skills to make the repairs. If there is a breakdown in the wiring, replacing the points will not have the desired effect. The same is true of repairing instruction. If a unit needs items replaced, changing the references is not likely to remedy the problem. In addition, identifying the trouble spot is insufficient by itself; the content specialist and the educational technologist must have the skills to select or develop an effective solution.

As a result of the development and evaluation of this revision model, future research may be proposed. An empirical test should be made of the revised model with the more stringent content revision criteria. Three procedural changes that could also be made are: (a) within-course reviews, a topic currently being investigated by Dunn (1971); (b) initiation of small group help sessions as used by Chung (1970); and (c) specified intracourse deadlines to prevent procrastinators from leaving the entire course to the last week or few days.

Another related investigation suggested by the results from this and the Lawler Study is in the area of student strategies, particularly the "successful" strategy 2. Questions to be posed are whether or not the self report is accurate, and whether non-strategy 2 students could be encouraged to adopt an atypical strategy and thereby raise their achievement levels.

In addition, the data collecting process could be improved by changing the time it is gathered, by finding additional sources of data, and by sharpening the data gathering instruments. Improving student performance on each item must improve the total score. In order to identify the problems students have with items, student responses on the in-course tests should be analyzed. One or two students that make an error on an item should be interviewed to find the cause. Additional sources of data might be job performance in a related field after instruction. If the course was a prerequisite for a later course, student performance in the later course might be of interest.

Since students cannot spend an infinite amount of time filling out forms or being interviewed, the data-gathering instruments themselves should be refined and rationed. The proven useful types of information should be given priority and collected only when necessary.

Summary

The application of the revision model, while not achieving the desired goal of bringing 80 percent of the students to 80 percent criterion, improved student performance considerably. In spite of the fact that the amount of work was decreased by about one third, the students progressed more slowly through the course. They still felt there was more work than for a usual three-hour course. Attitudes remained very much the same from quarter to quarter, and throughout the quarter. The revisions were not as effective for the CI class probably because the students had no opportunity to repeat module tests and the fact that the emphasis given by the professor was different from that in the guide.

Possible changes in the model include: raising the item criterion level, changing procedures to include one or more deadlines in the course in order to avoid mass learning at the end of the course, and sharpening the data-collection process and instruments.

CHAPTER VII

SUMMARY

This study involved the development, implementation, and empirical testing of a revision model for systematically designed educational materials. The investigation provided needed empirical evidence that given a revision subsystem, instructional materials and course operational procedures can be developed which insure that a high proportion of students reach a given level of mastery.

The development of the revision model was based on the limited literature on formative evaluation and upon several documented, data-based revision procedures. The model divides the revision process into two parts, content changes and procedural changes. The former, content changes, focuses on modules, objectives, diagnostic items, instructional materials, and the remedial prescriptions. Revision decisions are based upon data collected from measures of student performance, attitudes, and opinions, and upon the judgements of a content expert and an educational technologist. The types of revision are (1) inclusion, exclusion, or changes in scope, and (2) increased congruence of objectives, items, instructional materials and prescriptions. The criteria for determining the need for changes are item error rates, unit and total scores, and student comments.

Procedural revision refers to changes in the instructional process. The focus is on pretesting, orientation, in-course operations, posttesting, and grading. Revision decisions are based on the same data as that used for content changes, as well as solicited comments from students. The kinds of procedural revisions are those changes related to the type and manner of data collection, information

flow to the students, sequencing, pacing, student and teacher roles, and the grading system. The criteria for judging the need for changes, in addition to performance data, are students' and experts' judgements.

The revision model was implemented with a required course in health education for elementary education majors at Florida State University. The subjects were the students enrolled in the course in each of two successive quarters. Sections of the course were randomly assigned to two treatments: computer managed instruction (CMI) and conventional instruction (CI). The instruction in the CMI sections was individualized while the CI sections were professor managed and group paced. The instructional materials for the course were developed using a systems approach model. The instruction was modularized; each module included: objectives, sample test items, selected instructional materials, diagnostic tests, remedial prescriptions, and posttests.

The implementation of the revision model was based upon the results from the first quarter of operation. During the first implementation of the course only 17 percent of the students in the CMI group reached criterion of 80 percent or more on the final, criterion-referenced examination.

The course was revised between quarters according to the revision model. The results of the use of the model were evaluated in terms of overall student performance as well as sub-unit performance by items, objectives, and modules. Time to course completion, attitudes, and special questionnaires were also analyzed. With the revised course, 71 percent of the students in the CMI group reached criterion. Attitudes were unchanged.

Identifying those components of the revision model which were most effective was made difficult by the model itself since its purpose is to identify deficiencies at numerous sources in each instructional unit. Since each objective had a unique set of deficiencies, only the identification of the appropriate problems and the selection of appropriate solutions would result in improved student performance.

On the basis of the empirical test of the model, several revisions are suggested. For instance, it appears that criteria for all unit revisions should be equal to or greater than the criterion for the total course. Additional suggestions are related to data collection procedures, evaluation instruments, and student pacing.

APPENDIX A

SAMPLE MODULE DESCRIPTION FROM THE STUDENT GUIDE

Module: Nutrition

As is true of most of these units a whole course or many courses could be made of this one. We are currently facing a world food crisis. At home we have underpriviliged children who suffer from malnutrition due to poverty and ignorance. When a teacher observes these children she can give them immediate help with free or below average price lunches. She can also help break the cycle by teaching them about good eating habits.

OBJECTIVE 1:

The student will be able to match symptoms or diseases of malnutrition with the deficient nutrients.

(The terms "Essential 4," Four basic food groups and the four groups on page 294 of Wheatley are all the same.)

Sample Test Situation:

A lack of protein may cause:

1 beriberi
2 scurvy
3 ricketts
4 pellegra
* 5 none of these

Primary References:

Wheatley and Hallock, Health Observation of School Children, McGraw-Hill Book Company, New York, 1965. pp. 285-291, 479-480.
Ahrens, Richard A. Nutrition for Health, Wadsworth Publishing Company, Inc. Belmont. 1970. pp. 8,12-13,25

Secondary References:

Schifferes, Justus J., Healthier Living, John Wiley & Sons, Inc., New York. 1970, Chapter

APPENDIX B

STUDENT ATTITUDE TOWARD COMPUTER MANAGED INSTRUCTION

Developed by Bobby R. Brown

This is not a test of information; therefore, there is no one "right" answer to a question. We are interested in your opinion on each of the statements below. Your opinions will be strictly confidential. Do not hesitate to put down exactly how you feel about each item. We are seeking information, not compliments; please be frank.

Please respond to each of the following statements by marking your machine-scorable answer sheets according to the following code:

1. Strongly disagree
2. Disagree
3. Uncertain
4. Agree
5. Strongly agree

---

1. While taking Computer Managed Instruction I felt challenged to do my best work.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

2. The material presented to me by Computer Managed Instruction caused me to feel that no one really cared whether I learned or not.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

3. The method by which I was told whether I had given a right or wrong answer became monotonous.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

4. I was concerned that I might not be understanding the material.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

5. I was not concerned when I missed a question because no one was watching me anyway.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

15. As a result of having studied some material by Computer Managed Instruction, I am interested in trying to find out more about the subject matter.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

16. In view of the time allowed for learning, I felt too much material was presented.

All the time	Most of the time	Some of the time	Only occasionally	Never

17. I was more involved in running the machine than in understanding the material.

All the time	Most of the time	Some of the time	Only occasionally	Never

18. I felt I could work at my own pace with Computer Managed Instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

19. Computer Managed Instruction makes the learning too mechanical.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

20. I felt as if I had a private tutor while on Computer Managed Instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

21. I was aware of efforts to suit the material specifically to me.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

22. I found it difficult to concentrate on the course material because of the hardware.

All the time	Most of the time	Some of the time	Only occasionally	Never

23. The Computer Managed Instruction situation made me feel quite tense.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

24. Questions were asked which I felt were not relevant to the material presented.

All the time	Most of the time	Some of the time	Only occasionally	Never

25. Computer Managed Instruction is an inefficient use of the student's time.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

26. I put answers in knowing they were wrong in order to get information from the machine.

Quite often	often	occasionally	Seldom	Very Seldom

27. Concerning the course material I took by Computer Managed Instruction, my feeling toward the material <u>before</u> I came to Computer Managed Instruction was:

Very favorable	Favorable	Indifferent	Unfavorable	Very unfavorable

28. Concerning the course material I took by Computer Managed Instruction, my feeling toward the material <u>after</u> I came to Computer Managed Instruction is:

Very favorable	Favorable	Indifferent	Unfavorable	Very unfavorable

29. I was given answers but still did not understand the questions.

Very often	Often	Occasionally	Seldom	Very seldom

30. While on Computer Managed Instruction I encountered mechanical malfunctions.

Very often	Often	Occasionally	Seldom	Very seldom

31. Computer Managed Instruction made it possible for me to learn quickly.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

32. I felt frustrated by the Computer Managed Instruction situation.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

33. The responses to my answers seemed to take into account the difficulty of the question.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

34. I could have learned more if I hadn't felt pushed.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

35. The Computer Managed Instruction approach is inflexible.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

36. Even otherwise interesting material would be boring when presented by Computer Managed Instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

37. In view of the effort I put into it, I was satisfied with what I learned while taking Computer Managed Instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

38. In view of the amount I learned, I would say Computer Managed Instruction is superior to traditional instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

39. With a course such as I took by Computer Managed Instruction, I would prefer Computer Managed Instruction to traditional instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

40. I am not in favor of Computer Managed Instruction because it is just another step toward de-personalized instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

APPENDIX C

ATTITUDE TOWARD HEALTH EDUCATION

Directions: Please respond to each of the following statements by marking your machine-scorable answer sheets according to the following code:

1 - strongly agree

2 - agree

3 - uncertain

4 - disagree

5 - strongly disagree

---

1. Health education is of great value
2. I really enjoy health education
3. Health education is profitable to everyone who takes it
4. Health education is very practical
5. Health education is a universal subject
6. I could do very well without Health education
7. I am not interested in health education
8. I see no value in health education
9. Health education is based on "fogy" ideas
10. Health education is a waste of time
11. The very existence of humanity depends on health education
12. If I had my way, I would compel everybody to take health education
13. Health education gives students knowledge to help interpret problems that they will meet in life
14. Health education serves the needs of many people
15. Health education might be worth more if it were taught right
16. Health education seems to be a necessary evil
17. Health education cannot benefit me

18. Health education is more a plague than a study

---

[1]Item 15 was not used in the analysis as it was considered ambiguous by the students and investigator.

APPENDIX D.

STUDENT STRATEGY QUESTIONNAIRE (Form A)

Students vary considerably in the "strategies" they employ in meeting course requirements or assignments. Of course, many students use different strategies for different types of courses, i.e., one might not study chemistry in the same manner as history.

This questionnaire describes 5 common strategies and asks you to rate yourself on each strategy as to how typical it is of your general strategy. Please read each carefully and respond honestly by circling the number of your choice on each scale. Your response has no bearing on your course evaluation.

Strategy 1: I usually put off all studying and/or course work as long as possible. I seem to work more efficiently when the "pressure is on" to meet an upcoming deadline. I usually procrastinate.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 2: I usually complete my course work at a steady, consistent rate. I feel a commitment to work steadily week after week so that I won't ever get behind.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 3: I usually study or spend my time on only those course topics which are of interest to me. I don't usually study that material which doesn't interest me.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 4: I usually study or spend my time on only those topics that I don't know. If I'm satisfied with my knowledge of an area, I let it go; if I'm unsatisfied, I study it well.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 5: I usually study everything that is recommended by the course instructor. I will typically read all the assigned material for a course, and often read further in order to really understand the subject.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

My usual strategy is most like Strategy Number (circle one):

1 2 3 4 5

APPENDIX E

STUDENT STRETEGY QUESTIONNAIRE (Form B)

At the beginning of the course, you were asked to respond to a questionnaire about your typical strategy in meeting course requirements. This questionnaire is very similar, however, you are now asked to rate yourself on each of the 5 strategies shown below, as to how they describe the strategy you used in this course. Read each carefully and respond honestly by circling the number of your choice on each scale. Your responses have no bearing on your course evaluation.

Strategy 1: I usually put off all studying and/or course work as long as possible. I seemed to work more efficiently when the "pressure was on" to meet an upcoming deadline. I usually procrastinated.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 2: I usually completed my course work at a steady, consistent rate. I felt a committment to work steadily week after week so that I never got behind.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 3: I usually studied or spent my time on only those course topics which were of interest to me. I didn't usually study that material which didn't interest me.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 4: I usually studied and spent my time on only those topics that I didn't know. If I was satisfied with my knowledge of a module, I let it go; if I was unsatisfied, I studied it well.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 5: I usually studied everything that was recommended. I read all the primary references and often read the secondary and alternative references in order to really understand the subject.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

My strategy in this course was most like Strategy Number (circle one).

1 2 3 4 5

APPENDIX F

LIST OF ELEVEN MODULES WITH ABBREVIATIONS AND

NUMBER OF OBJECTIVES IN EACH

MODULE NAME	ABBREVIATION	NO. OF OBJECTIVES IN MODULE
School Health	SH	3
Growth	GR	1
Mental Health	MH	1
Sex Education	SE	3
Vision	VI	3
Hearing	HR	2
Mood Modifiers	MM	2
Communicable Disease	CD	2
Dental Health	DH	2
Special Topics	ST	2
Nutrition	NU	2

APPENDIX G

CHANGES MADE IN HEALTH EDUCATION COURSE AS A RESULT OF APPLYING THE REVISION MODEL

MODULE	OBJECTIVE NUMBER	CHANGE	REASON
First Aid	01	dropped	not covered in conventional class used as sample objective
Mood Modifiers	01	slightly reworded	clarity
		sentence added	emphasis
Communicable Diseases	01	combined and re-written	overlapping objectives
	02		
	03		clarity and emphasis
Healthful Environment	01	dropped	not covered in conventional class
	02	dropped	not covered in conventional class
	03	dropped	not covered in conventional class
Special Topics	01	reworded	clarity
	02	none	
Sex Education	01	Slightly reworded	clarity
	02	reworded	clarity and emphasis
	03		
Mental Health	01	none	
	02	dropped	Student complaint & content expert's advice:Unit was on one man's opinion.
Nutrition	01	dropped	Content experts advice. Few U.S. school children show clinical symptoms of malnutrition
	02	slightly reworded	clarity
	03	reworded	clarity
Vision	01	slightly reworded	clarity
	02	none	
	03	sentence added	expansion of objective

Hearing	01	none	
	02	none	
Growth	01	none	
Dental Health	01	none	
	02	none	
Consumer Health	01	dropped	not covered in conventional class
	02	dropped	not covered in conventional class
School Health	01	slight rewording	clarity
	02	none	
	03	slight rewording	clarity

*order conforms to Lawler (1971).

APPENDIX H

SUMMARY OF ITEM CHANGES MADE FOR THE WINTER QUARTER AS A RESULT OF APPLYING THE REVISION MODEL

ITEM	REASON FOR CHANGE	TYPE OF CHANGE
SH0104	too easy (.94)'	dropped
SH0112	too easy (.92)'	dropped
SH0205	bad distractor	distractor dropped
SH0210	random selection for unique item	moved to prepost test only
SH0311	more than one CA[2].	dropped
SH0312	too similar to SH0303	dropped
GR0102	too easy (.84)'	dropped
GR0106	two CA's[2]	one distractor changed
GR0111	too easy (.94)'	dropped
SE0105	student complaint-"picky"	dropped
SE0112	random detention	dropped
SE0204	instructional materials inappropriate	dropped
SE0211	selected deletion	dropped
SE0301	too easy (.81)'	dropped
SE0302	too easy (.80)'	two distractors changed
SE0304	unimportant	replaced
MH0102	random selection for unique item	moved to pre post test only
MH0103	ambiguous	replaced
MH0108	too many CA's	dropped
MH0111	too easy	dropped
MH0112	error in stem	stem changed

1. Percent of students to answer the question correctly on the pretest
2. Correct answer.

ITEM	REASON FOR CHANGE	TYPE OF CHANGE
V10104	random selection for unique item	moved to pre post test only
V10109	too easy (.83)[1]	dropped
V10112	did not match objective	moved to objective V10300
V10207	student complaint	dropped
V10208	random selection for unique item	moved to pre post test only
V10209	random deletion	dropped
V10301	too easy (.82)[1]	dropped
V10302	too easy (.81)[1]	dropped
V10303	random selection for unique item	moved to pre post test only
HR0102	random selection for unique item	moved to pre post test only
HR0111	illustration unclear	dropped
HR0112	random deletion	dropped
HR0206	unappropriate for children	dropped
HR0211	CA[2] different in two books	dropped
MM0102	student complaint ambiguous	dropped
MM0110	random selection for unique item	moved to pre post test only
MM0112	professor objection-answer obvious	dropped
MM0202	too easy (.97)[1]	replaced
MM0205	random selection for unique items	moved to pre post test only

MM0212	random deletion	dropped
CD0101	too easy (.97)[1]	dropped
CD0102	too easy (.90)[1]	dropped
CD0104	random selection for unique item	moved to pre post test only
CD0106	unusual format	retyped in more conventional form
CD0201	unappropriate for revised objective	replaced by CD0206
CD0203	too like CD0204	replaced by CD0303
CD0208	inappropriate for revised objective	replaced by CD0310
CD0211	inappropriate for revised objective	dropped
CD0212	inappropriate for revised objective	dropped
CD0306	random selection for unique item	moved to pre post test only
DH0101	random deletion	dropped
DH0108	random selection for unique item	moved to prepost test only
DH0109	random deletion	dropped
DH0202	unimportant	dropped
DH0203	random selection for unique item	moved to prepost test only
DH0208	random deletion	dropped
ST0107	random selection for unique item	moved to pre-post test only
ST0111	unimportant	dropped
ST0112	unimportant	dropped
ST1215	poorly worded	replaced
ST0203	bad distractors	one dist added

ST0214	random selection for unique item	moved to prepost test only
ST0208	too easy (.82)[1]	dropped
ST0209	too easy (.81)[1]	dropped
ST1211	bad distractors	2 distractors revised
NU0203	too easy (.83)[1]	dropped
NU0210	inappropriate for revised objective	moved to NU0300
NU0211	random selection for unique item	moved to prepost test only
NU0302	inappropriate for revised objective	dropped
NU0303	ambiguous	dropped
NU0307	random selection for unique item	moved to prepost test only
NU0309		replaced by NU0210

APPENDIX I

LIST OF PRESCRIPTION CHANGES MADE BY OBJECTIVE AS A RESULT OF APPLYING THE REVISION MODEL

Objective	Type of off-line prescription
SH01	none
SH02	paraphase of questions
SH03	keyed to questions
GR01	keyed to questions
SE01	keyed to questions
SE02	rephrase of objective in more detail
SE03	rephrase of objective in more detail
MH01	rephrase of objective in more detail
VI01	rephrase of objective in more detail
VI02	paraphrase of questions
VI03	keyed to questions
HR01	rephrase of objective in more detail
HR02	key to questions
MM01	rephrase of objective in more detail
MM02	rephrase of objective in more detail
CD01	rephrase of objective in more detail
CD02	rephrase of objective in more detail
DH01	paraphrase of questions
DH02	keyed to questions
ST01	rephrase of objective in more detail
ST02	keyed to questions
NU02	rephrase of objective in more detail
NU03	paraphrase of questions

APPENDIX J

SAMPLE OF STUDENT PRETEST RESULTS FORM WITH RECOMMENDED STRATEGIES

MODULE NAME	SH	GR	HH	SE	VI	HR	MM	CD	DH	ST	NU	TOTAL
MAXIMUM SCORE	12	4	4	12	12	8	8	8	8	8	8	92
YOUR SCORE												
RECOMMENDED STRATEGY												

A = review the material and take the module test at your earliest convenience.

B = read the material thoroughly, then take the module test.

C = read the material thoroughly, and attend the discussion session before taking the module test.

APPENDIX K

DESCRIPTION OF THE GRADING SYSTEM

Total possible points:

Textbook evaluation maximum	= 97 x 1 =	97
Midterm maximum (CI)	= 115 x 2 =	230
or		
Module maximum (CMI)	= 115 x 2 =	230
Final exam maximum	= 92 x 3 =	276
		603
Extra credit test maximum		13
		616

The letter grades assigned were as follows:

A = 540 or above

B = 480 to 539

C = 420 to 479

D = 360 to 419

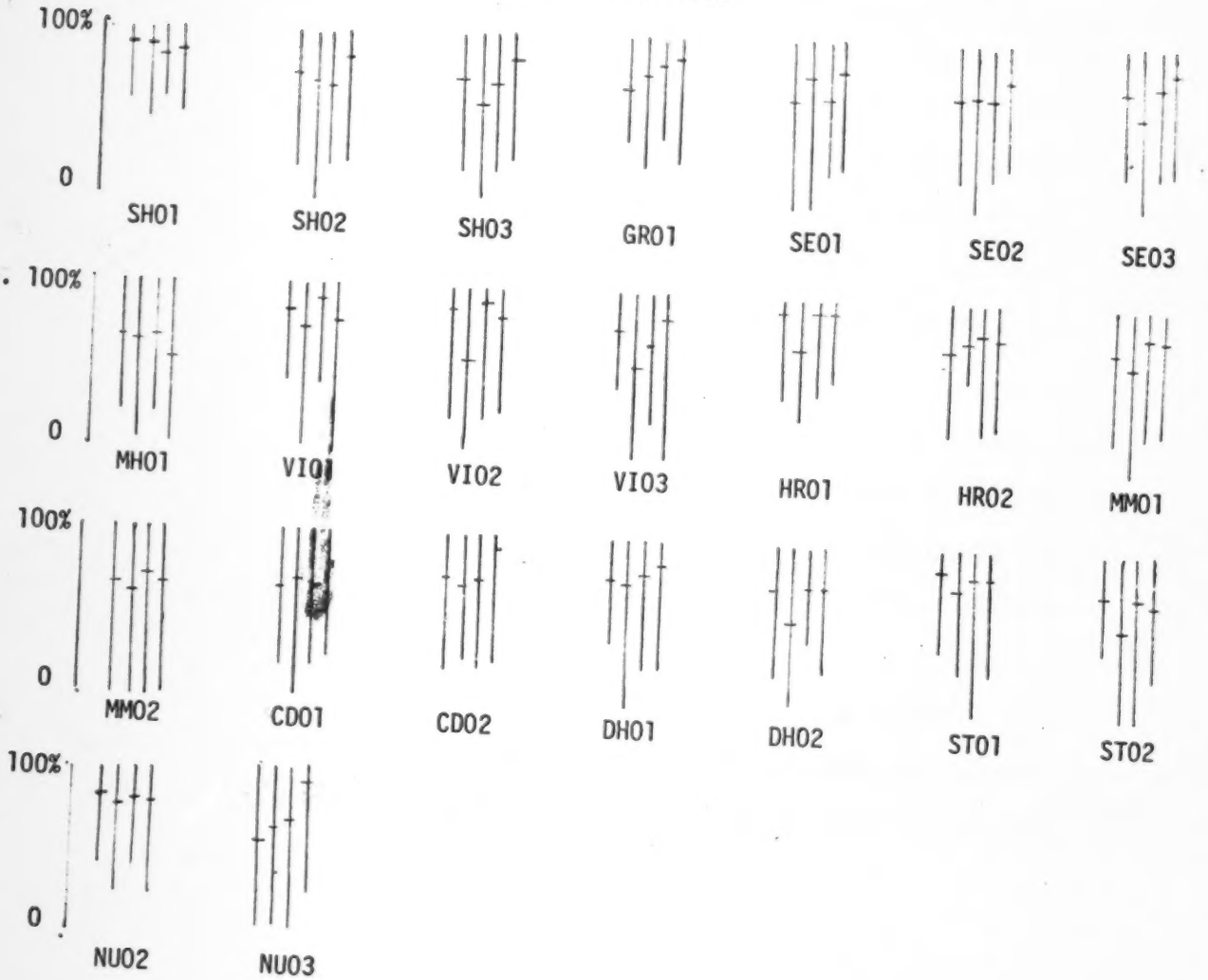
E = 359 or below

The formula for computing total points earned is:

TBE x 1 + MIDTERM TOTALS x 2 + FINAL EXAMINATION SCORE x 3.

APPENDIX L

RANGE AND MEANS FOR CMI STUDENTS' POSTTEST SCORES BY OBJECTIVES



KEY: Four vertical lines, the first one is the actual range for fall midterm test, the second one is for the fall final test, the third one is for the winter midterm test, and the fourth one is for the winter final test. The small horizontal bar indicates the mean.

APPENDIX M

Regression Equations with G in Student Reaching Criterion (100 was added to the criterion to make all gain scores positive.)

	EQUATION	R	F-RATIO	SIGNIFICANCE LEVEL
1.	149.7 + 36.9 (I-UNIQ) - 36.3 (P-QUGS) - 24.3 (P-PARA)	.69	5.622	N.S.
2.	136.2 + 37.9 (I-UNIQ) - 3.1 (I-REV) - 22.5 (P-OBJ)	.62	3.963	N.S.
3.	135.2 + 37.1 (I-UNIQ) + .4 (I-REPL) - 22.3 (P-OBJ)	.62	3.903	N.S
4.	135.2 + 37.1 (I-UNIQ) + 1.2 (G-OBJ) - 22.9 (P-OBJ)	.62	3.914	N.S.
5.	135.2 + 37.4 (I-UNIQ) - .4 (G-SI) - 22.2 (P-OBJ)	.62	3.904	N.S.
6.	135.4 + 38.3 (I-UNIQ) - 2.3 (G-REF) - 23.0 (P-OBJ)	.62	3.917	N.S.
7.	132.7 + 34.7 (I-UNIQ) - 17.5 (P-OBJ) + 8.1 (P-PARA)	.64	4.404	N.S.
8.	138.8 + 37.6 (I-UNIQ) - 22.4 (P-OBJ) - 4.9 (N-EASY)	.64	4.339	N.S.

APPENDIX N

DEBRIEFING QUESTIONNAIRE FOR THE CMI GROUP

SEVERAL INNOVATIONS WERE MADE IN HEE319 TO HELP YOU LEARN THE MATERIAL. WE NEED YOUR REACTIONS TO THESE CHANGES IN ORDER TO EVALUATE THEM. PLEASE RESPOND HONESTLY. IT WILL NOT AFFECT YOUR GRADE.

Check the correct answer:

1. How was the amount of reading and studying required as compared to other three hour courses?

   more___
   about the same___
   less___

2. How would you rate the objective as stated in the guide?

   very helpful___
   of some help___
   a handicap___

3. How would you rate the sample test items?

   very helpful___
   of some help___
   a handicap___

4. Did you think being scored by each objective was helpful for studying for the final?

   very helpful___
   a little helpful___
   no help___

5. Did you get "study sheets" from the proctor when you didn't meet criterion on an objective?

   rarely, if ever___
   sometimes___
   always___

6. Did you use the "study sheets"?

   not at all___
   some___
   a lot___

7. Were they helpful to you in studying for the final?

   not at all___
   some___
   a lot___

8. Did you repeat module tests?

none____
some____
many____
all of them____

9. If so, was it helpful in preparing for the final?

not at all____
some____
a lot____

10. Did instant error correction on the module tests make you nervous?

not at all____
some____
very much so____

11. Did you find instant error correction on the module tests helpful?

not at all____
some____
very much so____

12. The trial module (First Aid) on the computer was intended to bring you to the center and make you comfortable with the computer. Did it achieve that for you?

made me never want to come back____
no help at all____
helped me a little____

13. How often did you attend the weekly discussion session?

never____
1 to 3 times____
4 to 7 times____
everytime____

14. Did you think the human interaction in the discussion sessions helped the course?

not at all____
a little____
very much____

15. How do you rate the films?

usually poor____
all right____
learned a lot____

16. The films:

introduced new content____
were redundant with the text____
were redundant with the lectures____
seemingly were not intended for college level____

17. Did you like having the opportunity to take the final early if you wished?

yes, and I took it early____
yes, and I wish I had taken it early____
yes, but I needed the extra time to study____
no____

18. Did you like the idea of having the grading plan spelled out at the beginning of the course?

yes____
a little____
not at all____

19. Did you like being graded on what you did rather than being graded on a curve?

not at all____
a little____
yes____

20. Please write any comments that you wish on the back of this sheet.

APPENDIX O

DEBRIEFING QUESTIONNAIRE FOR THE CI GROUP

SEVERAL INNOVATIONS WERE MADE IN HEE319 TO HELP YOU LEARN THE MATERIAL WE NEED YOUR REACTIONS TO THESE CHANGES IN ORDER TO EVALUATE THEM. PLEASE RESPOND HONESTLY. IT WILL NOT AFFECT YOUR GRADE.

Check the correct answer:

1. How was the amount of reading and studying required as compared to other three-hour courses?

   more____
   about the same____
   less____

2. How would you rate the objectives as stated in the guide?

   very helpful____
   of some help____
   a handicap____

3. How would you rate the sample test items?

   very helpful____
   of some help____
   a handicap____

4. Did you think having the midterm exam scores broken down by objectives was helpful for studying for the final?

   very helpful____
   a little helpful____
   no help____

5. Did you use the "study sheets" returned to you with the mid-term grades?

   not at all____
   some____
   a lot____

6. Were the study sheets helpful to you in studying for the final?

   not at all____
   some____
   a lot____

7. How do you rate the films?

   usually poor____
   all right____
   learned a lot____

8. The films:

   introduced new content____
   were redundant with the test____
   were redundant with the lectures____
   seemingly were not intended for college level____

9. Did you like the idea of having the grading plan spelled out at the beginning of the course?

   yes____
   a little____
   not at all____

10. Did you like being graded on what you did rather than being graded on a curve?

   not at all____
   a little____
   yes____

11. Please write any comments that you wish on the back of this sheet.

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Adair, Hansen, Rayner, and Agarwal, Two simulated inquiry environments: a social simulation game and a CAI based information retrieval system. Tech Memo No. 16, Computer Assisted Instruction Center, Florida State University, May, 1970.

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